REPORT OF THE COMMISSION

ON THE

NATURE, PATHOLOGY, CAUSATION AND PREVENTION OF DYSENTERY AND ITS RELATIONSHIP TO ENTERIC FEVER.

Appointed by the Secretary of State for War, August, 1900.

Presented to Parliament by Command of His Majesty.

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INTRODUCTION.

The members of the Commission arrived in Cape Town in the first week of September, 1900, and after spending a few days there proceeded to Bloemfontein, where they remained nearly a month investigating as far as possible after the event, the causes which gave rise to the Bloemfontein epidemic of dysentery and enteric fever and the conditions still remaining for the continuance of these diseases. Kroonstad was visited later with the same object. Johannesburg and Pretoria were then visited to ascertain which would be the most suitable for the establishment of a laboratory to study the bacteriological and pathological characters of dysentery and their relationship, if any, to enteric fever. Pretoria was chosen as there were more hospitals there than at Johannesburg, and as it received most of the sick in an acute state of illness from the large number of troops operating at the front.

Some time was occupied in arranging the laboratory, which was undertaken by one of the members while the two others went down to Komatipoort, inspecting on the return journey some 19 camps. Three months were spent in the laboratory at the season of the year when dysentery is usually most prevalent. The laboratory was then handed over to a medical officer of the R.A.M.C. to carry on analytical and bacteriological work connected with the Army, and the Commission were about to commence a series of inspections of camps in Natal, the Orange River Colony, and Cape Colony, when plague broke out in Cape Town and on its threatening to become serious, one of the members, with the permission of the Secretary of State for War, was detached from the Commission and his services lent to the Government of Cape Colony. The other members proceeded to visit the camps, and later their services were made use of by the military authorities for general sanitary and plague purposes. Subsequently towards the end of August, when plague no longer threatened to spread, the other member of the Commission went over somewhat the same ground as that visited by his colleagues in March and April; the Commission reassembled in London early in November for the purpose of drawing out the report.

When the Commission met at Cape Town in September, 1900, it was decided to divide the work into two parts:—

(*a*) Laboratory work.

(*b*) Inspection of camps, water supply, &c.

Lieut.-Colonel Bruce was asked to undertake the first part as his share of the work of the Commission, and Colonel Notter and Professor Simpson undertook the second part.

The following report is accordingly divided into two parts. The first relates to the bacteriology and pathology of South African dysentery and its relationship to enteric.

The second part of the report deals with the sanitary or health aspects of the campaign, or the physical conditions giving rise to bowel complaints, dysentery, and enteric fever. From this aspect there is a closer relationship between the two diseases in that the media by which the causal agent gains an entrance into the body are the same, and that excremental filth plays an important part in the causation and spread of both diseases. Still, though many of the conditions associated with dysentery are similar to those of enteric fever yet all the conditions are not the same. Decomposition in food,

putridity and suspended matter in water together with chills being more especially connected with dysentery.

All the places referred to were visited except Paardeberg, much of the information relating to Modder River Camp, Bloemfontein, and the British prisoners in Pretoria had to be obtained from others, the conditions no longer existing, but the remainder came under the personal observation of the Commission. In this portion of the report the question of the prevention of dysentery and enteric fever in an army in the field is carefully considered and the changes to effect that purpose are suggested.

DAVID BRUCE,
Lieut.-Colonel R.A.M.C.

W. J. SIMPSON, M.D., F.R.C.P.

November 29, 1901.

STATEMENT BY COLONEL NOTTER.

(1) I take no exception to Part I of this report, but there is much in Part II from which I dissent.

(2) I think undue stress is laid upon the absence of special sanitary returns. With troops in the field, the units of which are often for days together moving rapidly, elaborate statistics are quite impossible.

In my opinion the circumstances are sufficiently met by the information contained in Army Form A 28, furnished by Principal Medical Officers daily to the General Officers Commanding, which is a summary of information received from medical officers with units.—[Chapter IV, pages 62 and 63.] *A copy of Army Form A 28 is shown as Appendix IV.*

(3) The Commission is stated to have been well satisfied with the condition of and arrangements at the Bloemfontein Waterworks. I cannot accept this statement, as I consider the safeguarding of the water at and above the intake was extremely faulty, and further the system of filtration was so crude as to secure little more than the mechanical separation of the grosser suspended matter. The character of the filtering media was not such as would ensure a vital action of purification.—[Chapter IV, pages 66–69.]

(4) Certain statements are made with regard to the water supply of West Fort, Pretoria, and the incidence of sickness attributable thereto. These facts are said to have come within the cognisance of the Commission. Personally I have no knowledge of their having come under our notice.—[Chapter V, page 70.]

(5) Further, some statements as to fouling of water near Pretoria by faulty burial of horses are suggestive of defective sanitary supervision on the part of the military authorities. As a matter of fact this duty in that locality devolved on the civil administration.—[Chapter V, page 71.]

(6) Too much is made of a failure to put a guard on a particular disused water supply. It must be remembered that the men at that time were getting but one night in bed per week, owing to the onerous duties then prevailing. The same criticism applies to what is said further on.—[Chapter V, page 71; Chapter VII, page 76.]

(7) The circumstances narrated in Chapter VI, pages 73 et seq., took place some time before the Commission arrived in South Africa, and appears to me to be hardly germane to the inquiry. The facts recorded were not submitted to the Commission, but only to Dr. Simpson by Dr. Von Gernet.

(8) The remarks in respect to Naaupoort were the outcome of observations made by Dr. Simpson alone, and constitute I believe an isolated case.—[Chapter VII, page 77.]

(9) The statement that it was the general exception for water to be filtered or boiled by regiments I consider to be far from the real facts. Commanding officers were most keen on this point, and in my experience it was rather the exception to find water not boiled or filtered.—[Chapter VII, page 77.]

(10) I consider the description given of the general state of camps to be grossly exaggerated. In my opinion, except in a few cases of camps occupied by Colonial and Irregular Forces, the general sanitary state of the camps was good. In connection with this same subject, I think the criticisms as to the absence of any sanitary organisation are hardly justified by the facts. There is an organisation, but it is inadequate in personnel. This has been intensified by the free employment of civil surgeons with the army in the field, who have had no training whatever in sanitary science or preventive medicine.—[Chapter IX, page 86.]

(11) The reference to absence of notification (page 89) has been already mentioned on pages 62 and 63.

(12) The allusion to Lord Wolseley I consider to be in doubtful taste, and should be omitted.—[Chapter IX, page 89.]

(13) The proposals put forward as to organisation of a sanitary personnel I regard as wholly unworkable. The placing of a non-commissioned officer of the R.A.M.C. as camp or sanitary quartermaster of a regiment is certain to lead to friction and inefficiency. Any N.C.O. employed on such duties with a unit must be in and of that unit.

Similarly, the suggestion of employing low-caste natives of India or other tropical countries for scavenging work would be of limited applicability, and quite out of the question for troops operating in Europe. A sanitary service to be efficient must be trained during peace for war. Under this proposed system this point seems to be lost sight of. —[Chapter IX, page 90.]

(14) The proposals made for adding corrosive sublimate to urine tubs I regard as puerile, especially as an army in the field does not carry urine tubs about with it.—[Chapter IX, page 91.]

(15) The suggestions made on pages 93 et seq. are in my opinion absolutely unworkable. In the first place the use of the term Army Health Corps is most objectionable, and the proposals to have a conjoint corps of officers, R.E. and R.A.M.C., is impracticable. The proposal seems to be based too much on civil municipal lines, where the medical officers of health and the borough engineer work under the same masters.

In the army such an arrangement could not be carried out, and the subsidiary suggestion to have a high sanitary officer independent of the P.M.O. (Army) is certain to lead to friction and failure.

(16) With the proposal to organise within the R.A.M.C. a cadre of officers specially trained in sanitation, I cordially agree, and I further approve of the development of regimental water and sanitary sections of executive sanitary work under their own officers. These men should receive special training, and be borne on the strength for those duties.—[Page 94.]

(17) The inclusion of Mr. Ritzo's report as to well boring appears to me to be redundant. As I have no personal knowledge of the circumstances under which he was employed, I disclaim any responsibility for the deductions drawn.—[Page 96.]

(18) I demur to so much of Part II of the report being taken up with details as to, and criticisms of, circumstances connected with the occupation by the army of camps at Modder River, Paardeberg, and Bloemfontein. Practically none of the facts therein referred to came under the actual observation of the Commission, as the events occurred some months before the Commissioners arrived in South Africa.

The opinions offered on these incidents are based almost entirely on hearsay or secondary evidence.—[Chapters III and IV.]

The report does not do justice to the work done by the Royal Engineers and other officers in South Africa. From a few isolated instances of apparent neglect of duty wholesale deductions are drawn, which in my opinion are not justified by facts. From personal inspection of most of the camps in South Africa I am convinced there has not been such a complete neglect of sanitary precautions as this report would seem to imply

J. LANE NOTTER,
Colonel, R.A.M.C.

PART I.

ON THE ETIOLOGY OF SOUTH AFRICAN DYSENTERY.

By Lieut.-Colonel David Bruce, R.A.M.C.

In spite of a considerable number of papers written on this subject during the last 15 years, the etiology of dysentery still remains obscure. Little also has been done to separate the various diseases which are at present included under the term dysentery, which after all is merely a name for a symptom.

Without entering into details I may say that when one looks back on the history of this disease during these years three main theories seem to arrest the eye :—

1st. The amœbic theory.
2nd. The specific bacillus theory.
3rd. The pathogenic rôle assumed by the bacillus coli theory.

In regard to the first theory, it seems, as the years pass, to be slowly assuming less imposing dimensions, to be gradually wearing away by the mere lapse of time rather than being swept away by any important discovery. Whether it will again assume its youthful vigour by having more light thrown on it is difficult to say.

I do not think the amœbæ coli is an etiological factor in the causation of dysentery in South Africa, as I have only met with amœbæ in a very few cases in dysenteric material examined there.

In regard to the second theory, of which Shiga and Flexner may be mentioned as exponents, in my opinion none of the bacilli brought forward are quite convincing. They have, as a rule, a strong likeness to some members of the protean coli group, and these bacilli, as everyone knows, are exceedingly hard to separate and differentiate.

In some of these investigations a good deal of reliance is placed on serum sedimentation, and the methods of using this test are open to criticism. Shiga, for example, mixes the serum with broth, rubs up a portion of a colony of the bacilli growing on agar-agar and makes a hanging drop preparation of the mixture. My experience may be different from that of others, but I have always been very suspicious of the serum sedimentation test even when carried out with many safeguards and controls, and I certainly would not be less suspicious of it when carried out in the above described rough haphazard manner.

The second must, therefore, be placed along with the amœbic in the non-proven pigeon-hole.

As for the third theory, it remains frankly in the region of speculation and has merely negative evidence as its sponsors.

I must frankly confess to thinking there is something rather fascinating in this theory. That some of these colon bacilli can give rise to very powerful poisons was seen in Pretoria when a horse which was given a few cubic centimetres of a broth culture of bacillus coli, var. A., intra-venously, died in a short time with all the post-mortem marks of acute blood poisoning.

Before leaving this part of the subject I would like to draw attention to a statement made by Dr. Washbourn in his Presidential Address to the Pathological and Bacteriological Section of the British Medical Association, 1901. He is reported as having stated that he had little doubt but that the

South African dysentery was the same disease as the Asylum dysentery described by Dr. F. W. Mott and Dr. Durham in this country. In that disease a micro-organism cultivated from the organs was described by Dr. Durham.

It is unfortunate that this is one of those very minute micrococci lying on the borderland of the invisible, which will not grow to the slightest extent on any of the solid media in use, and only to a small extent in ordinary broth. This micrococcus, from a perusal of Dr. Durham's paper, is evidently in his opinion the distinguishing feature of this kind of dysentery, but until this micrococcus is isolated from cases of South African dysentery, it is not permissible to definitely state that the disease is the same as Asylum dysentery.

I regret that I did not follow Dr. Durham's instructions more closely in my own examination of cases of South African dysentery, as I shall have failed to convince him that the organs in dysentery are sterile, which is the conclusion arrived at by me.

On our arrival in Pretoria it was determined to set up a small laboratory to study a little more closely the etiology of this disease, and especially as to whether any special micro-organism could be found to be associated with it.

Pretoria was considered the most suitable place for the purpose as it was the collecting station for the unhealthy districts lying to the east and north.

It must be mentioned here that South Africa is not the most suitable country for the study of dysentery. In times of peace before the war, severe, acute, fatal cases of dysentery were very rare. During my five years' service in South Africa before the war only one such case came under my observation. The great majority of the cases even in time of war, with its abnormal conditions, exposure and food, are by no means regular in phenomena or indeed very serious. With few exceptions, rest in bed, an aperient and mild diet are sufficient to cause the disappearance of the dysenteric symptoms in a few days.

South African dysentery seems to be a very different disease from that of Japan with its mortality of some 25 per cent. Hence it is difficult in South Africa to obtain suitable material, and on this rock the laboratory work of the Commission came somewhat to shipwreck. I shall describe shortly the conditions under which the work was done in Pretoria, and this will perhaps give some explanation of the paucity of the results.

By the kindness of Colonel Stevenson, R.A.M.C., at that time Principal Medical Officer with the Commander-in-Chief, we were provided with two excellent rooms in No. 2 Model School Hospital, situated within Pretoria, for the purpose of establishing a laboratory.

It was intended that this No. 2 Model School Hospital should be used chiefly as a dysenteric and enteric hospital, so that ample material would be at hand for the purpose of the investigation.

This was to be attained by making the rule that cases of these diseases coming into Pretoria for treatment would be sent to this hospital instead of the others, which comprised Nos. 2 and 7 General Hospitals and Nos. 1 and 2 School Hospitals. In practice, however, this rule was never carried out. It was a time of actual warfare, everyone was overtaxed with work, and the dysentery cases coming into Pretoria were placed in the hospital which happened at the time to be the nearest and the most convenient. Thus it happened that very few suitable cases of dysentery found their way to No. 2 Hospital and little or no opportunity was offered of studying the clinical aspect of the disease. The work then resolved itself into procuring material from the other hospitals, and that principally post-mortem material. Most of this material was, as a matter of fact, procured from No. 2 General Hospital, the Principal Medical Officer of which was Colonel Keogh, R.A.M.C., who was most assiduous in placing every assistance in his power at our disposal. Without his assistance the little material I managed in the long run to avail myself of would have been much diminished. When it is stated that No. 2 General Hospital was quite 2 miles from No. 2 Model School, and that this distance was increased to 4 miles by the fact that Pretoria was surrounded by a high barbed wire fence, which necessitated a long detour to get through

one of the openings, it will be granted that the work was carried on in the face of some difficulty. In the study of a difficult disease such as dysentery it is most essential that the cases be close at hand, and that facilities for their immediate examination be available. Instead of this I had to make, as a rule, the long journey of 4 miles, carrying the necessary instruments, &c., and then perform the examination in the extremely hot atmosphere of a tent.

It is not to be wondered at then that the results that are given in the following pages are not as full and satisfactory as might be wished or as was anticipated.

The first case examined occurred about the middle of November and the last about the middle of February, so that this part of the work of the Commission only lasted three months.

It was found impossible to devote more time to strict laboratory work as the Commission was due in England at the beginning of May. This was much too short a time for proper bacteriological study of this disease ; at least two years should be devoted in the first place to it.

The plan for work drawn up was as follows :—

In the living subject—

1. Daily notes of the symptoms, temperature, character of evacuations, &c.
2. Daily examination of blood as to the number of red and white blood corpuscles per cubic millimetre, also the enumeration of the various kinds of white blood corpuscles, and the presence of malarial or other micro-organisms.
3. The microscopic examination of the fresh evacuations for the presence of amœbæ or of any predominant micro-organism.
4. The cultivation and separation of the various bacteria most commonly found in the evacuations in the acute stage of dysentery.
5. Serum sedimentation tests with the blood serum of the patient and the different bacteria separated. The various bacteria were grown on agar-agar for 24 hours at 37° C., and then made into an emulsion with salt solution, containing 1 per cent. formalin, the emulsion made as near as possible of the same opacity by testing layers of the same thickness.

In the dead subject—

1. Description of the post-mortem examination as soon after death as possible.
2. Cultivations from the various organs, blood, bile, and intestinal contents, and the separation and identification of the various bacteria found. The cultures were made in various media, the most commonly used being agar-agar nutrient jelly. For example, if the spleen was the organ under examination, the centre of it was exposed by means of sterilised knives, and a fairly large quantity of the pulp removed, not by means of a platinum needle, but by means of a large lance-headed needle, so that a piece of pulp as large as a pea could be spread over the agar-agar. If a micro-organism is present in the spleen it ought to show signs of growth in pieces of the spleen itself. In cases of the bile the surface of the gall bladder was seared by means of a red hot iron and a sterilised capillary glass tube pushed through. Several drops were then poured over the surface of the agar-agar and collected at the bottom of the tube along with the fluid which usually collects there. If Dr. Durham's micrococcus had been present it would probably have grown in such a fluid. To separate the various species of bacteria I used principally agar-agar and gelatine plates.
3. Collection of serum from the pericardium for the purpose of sedimentation tests. These tests were made in capillary tubes in dilutions of from 1 in 10 to 1 in 200, and controls were made in every case.

There are some emulsions of bacteria which will sediment beautifully with anything or nothing.

4. Pieces of the various organs were placed in a fixing solution of perchloride of mercury for subsequent cutting into sections and examination.

This was the routine marked out at the beginning and carried out as far as possible in the following cases. The enumeration of the red and white blood corpuscles and the percentage constitution of the latter was stopped after several observations as no deviation of interest from the normal was found to occur.

The instructions given for the guidance of the Dysentery Commission stated that the connection between dysentery and enteric, if any such existed, was to be investigated. On this account every favourable opportunity was taken of making post-mortem examinations of cases of enteric, and subjecting them to the same procedure as in the cases of dysentery.

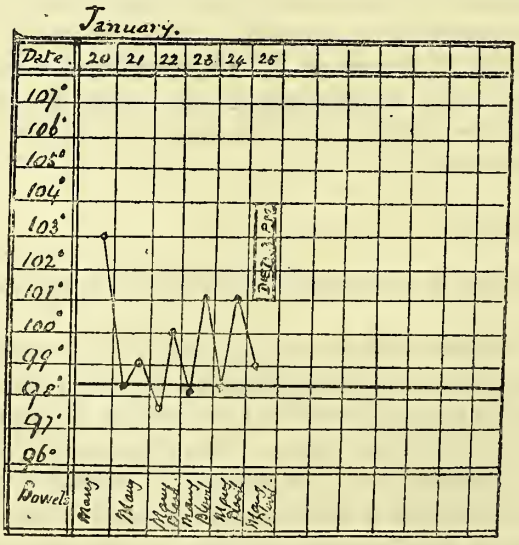
In all 18 cases of dysentery and seven of enteric came under examination, and are now shortly described.

DESCRIPTION OF THE CASES OF DYSENTERY EXAMINED.

Case 1.—Dysentery. Death on the 9th day.

History.—No. 5518 Private T. Maken, 2nd Manchester Regiment, age 22, was admitted to No. 2 Model School Hospital Pretoria, on January 20, 1901, suffering from symptoms of dysentery, and died on the 25th of the same month. He was stationed at the Erste Fabrican Camp near Pretoria. He was ill three days before coming into hospital. He passed a great deal of blood and suffered much abdominal pain.

The following chart represents the course of the disease :—



Post-Mortem Examination—½ hour after death.

The body was that of a well-nourished young man. A small quantity of fluid was found in the peritoneal cavity. There were no signs of peritonitis. The heart and lungs were healthy. The spleen was normal, and weighed 5 ozs. The liver was congested and slightly fatty, and weighed 4 lb. 4 ozs.

Small Intestine.—The mucous membrane was inflamed and roughened for about an inch above the ileo-cœcal valve. Peyer's patches were unthickened. There were no signs of enteric lesions.

Large intestine.—The whole of the large intestine presented a very remarkable condition. It was evidently in the first stage of dysenteric inflammation before ulceration has begun. From the ileo-cœcal valve to the rectum it was much thickened, and the mucous membrane was in a state of intense congestion. The colour generally was dark dusky red or maroon. No appearance

(To face Plate 2. between Pages 10 & 11.)

Plate I.

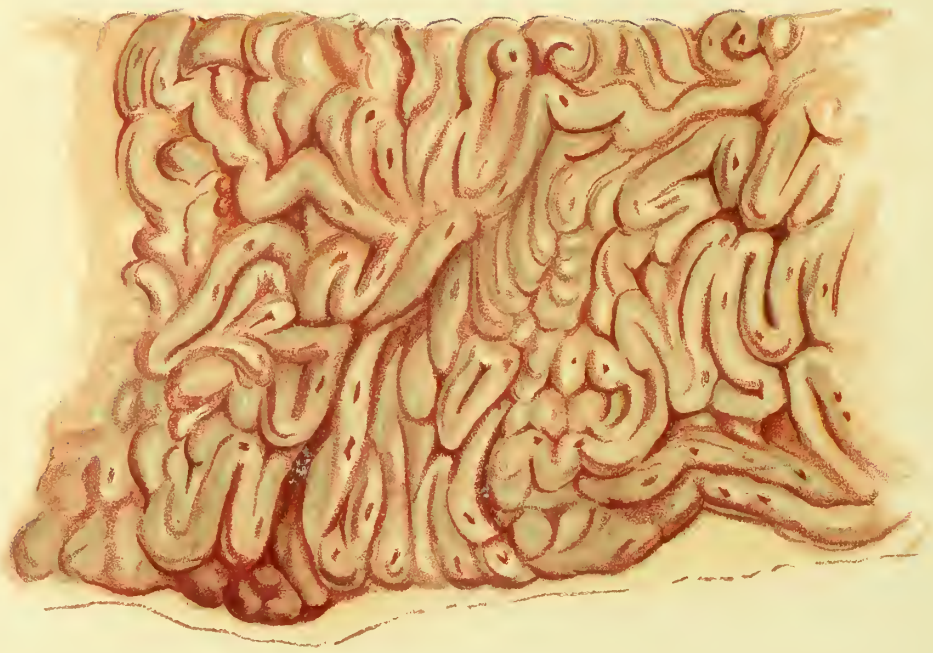


Fig. I.

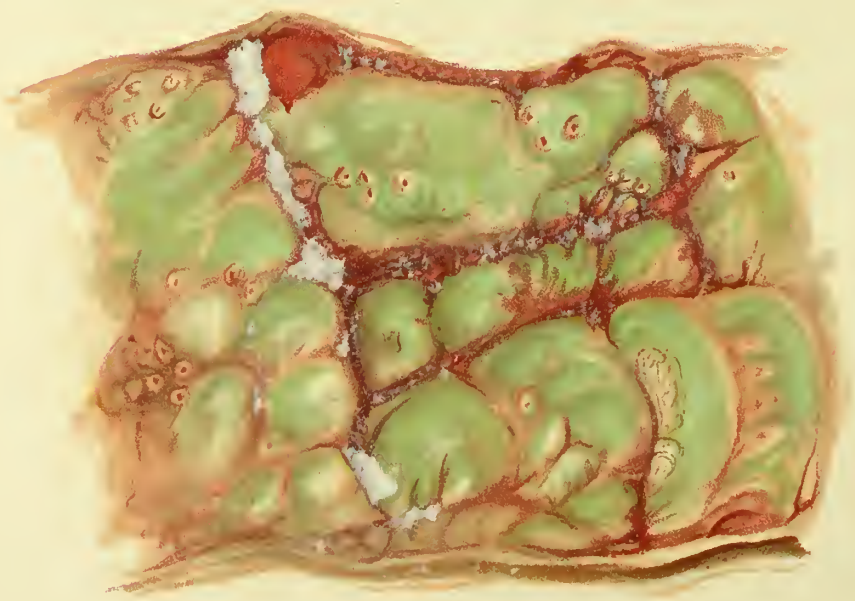


Fig. II.

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(To face Plate 1. between Pages 10 & 11.)

Plate II.

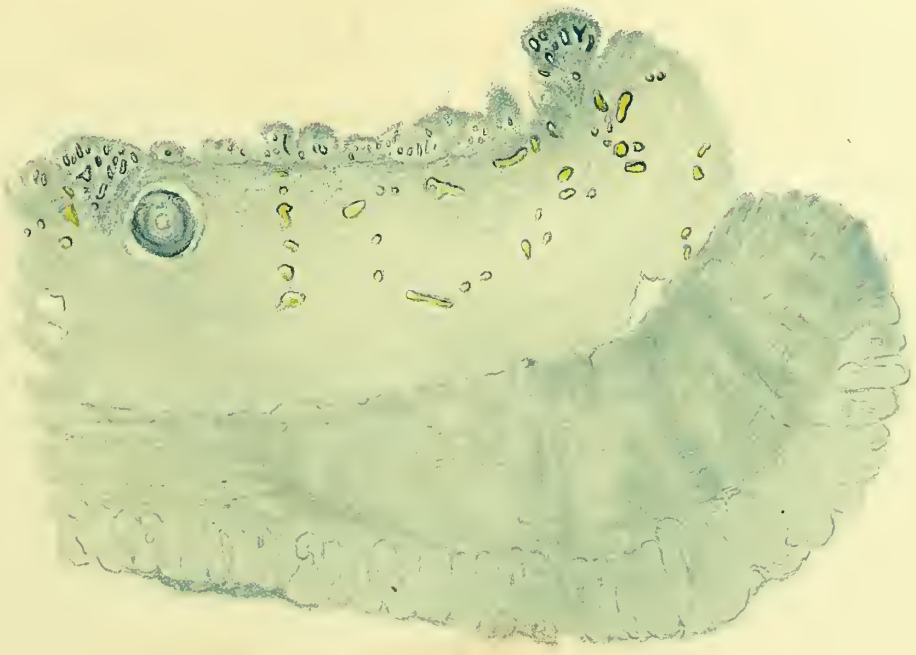

Fig. III.

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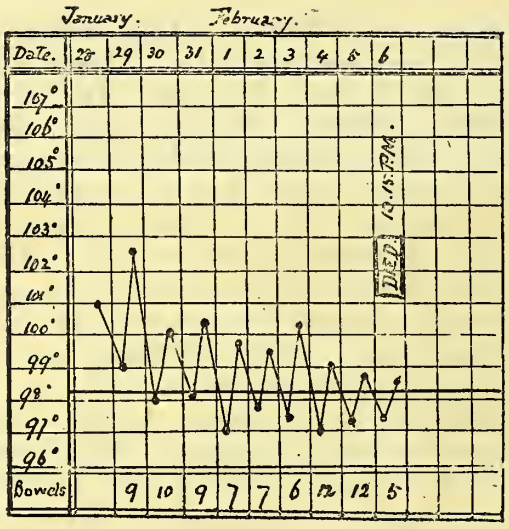

Post-Mortem Examination—12 hours after death.

The body was much emaciated, The spleen was not enlarged. The heart, lungs, liver, and kidneys presented nothing noteworthy. The stomach and small intestine were congested, but showed no signs of infiltration or ulceration. The mesenteric glands were enlarged.

Large intestine : The cœcum was thin, with here and there a few punctiform ulcers. The ascending colon was unthickened. The first six inches were not ulcerated, but beyond that small transverse, irregularly-shaped ulcers about half an inch in length appeared. These ulcers only implicated the mucous membrane, and had floors dark greenish in colour, the edges raised, slightly thickened, undermined, and dark red in colour. The ulcers in the ascending colon were not very numerous. Transverse colon : The mucous membrane of this part of the large intestine showed a much more advanced condition of dysenteric ulceration. Here what remained of it was in the form of circles and serpiginous ridges surrounded by necrotic ulcerated tissue. It was evident that the mucous membrane had been partly shed, leaving islands, circles, and ridges of a deep dusky red, standing out from the greenish-yellow ulcerated background. Fig. 1, Plate 3, on the opposite page represents the condition obtaining in the transverse colon, where quite half of the mucous membrane has fallen away, leaving a greenish ulcerated surface. This condition should be compared with Case 1 (Maken), where it is very evident the pathological process is exactly similar to this but in an earlier stage. The descending colon was much less thickened and ulcerated than the part just described. The rectum was ulcerated and slightly thickened throughout, and was of a darker colour than the large intestine generally, owing to a deposition of pigment in the superficial layers.

Microscopical Examination.—Intestinal contents. In hanging drop. Innumerable bacteria. No amœbæ.

Microscopical Examination of Sections.—Fig. 2 represents a section of the large intestine stained in meth. blue and magnified 10 times. Here at points the mucous membrane has sloughed, leaving exposed the ulcerated surface of the sub-mucous layer.

(To face page 12.)

Plate III.

Fig. I.

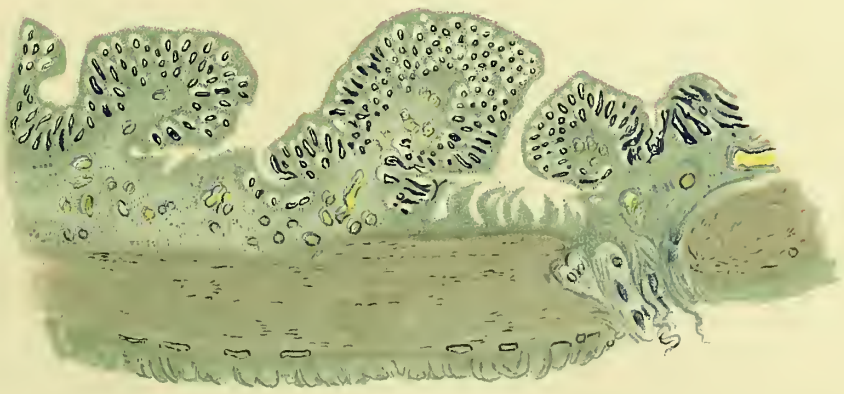

Fig. II.

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Cultures from Organs.

Organ.	Tube.	1 day.	4 days.	14 days.
Spleen	1	Sterile	Sterile	Small colonies
Spleen	2	Sterile	Sterile	1 small colony
Spleen	3	Sterile	Sterile	Sterile
Spleen	4	Sterile	Sterile	Sterile
Spleen	5	Sterile	1 small colony	Small colonies
Spleen	6	Sterile	Sterile	Sterile
Controls ..	1 and 2	Sterile	Sterile	Sterile
Liver	1	Sterile	Sterile	Sterile
Liver	2	Sterile	Sterile	Sterile
Bile	1	White growth	White growth	White growth
Bile . ..	2	White growth	White growth	White growth
Heart's blood ..	1	Sterile	Sterile	Sterile
Heart's blood ..	2	Sterile	Sterile	Sterile
Intestine ..	1	Copious growth	Copious growth	Copious growth
Intestine ..	2	Copious growth	Copious growth	Copious growth
Intestine ..	3	Copious growth	Copious growth	Copious growth
Controls ..	1 and 2	Sterile	Sterile	Sterile

Species of Bacteria Cultivated from Organs.

Spleen.—Streptococcus.
Broth : A flocculent deposit, the fluid remaining clear.
Agar : Small pale transparent colonies along edge of needle track.
Gelatine : Not liquefied.
Potato : No growth.
Milk : Coagulated.

Spleen.—Micrococcus. Medium size.
Broth : Rendered cloudy. No pellicle. No indol reaction.
Agar : Pure white layer.
Potato : Strong white growth.
Milk : Coagulated.
Litmus : Reddened and then reduced.
Sugar Gelatine : No gas.
Parietti : 2 per cent.

Bile.—Bacillus coli, var. A.

Serum Sedimentation.

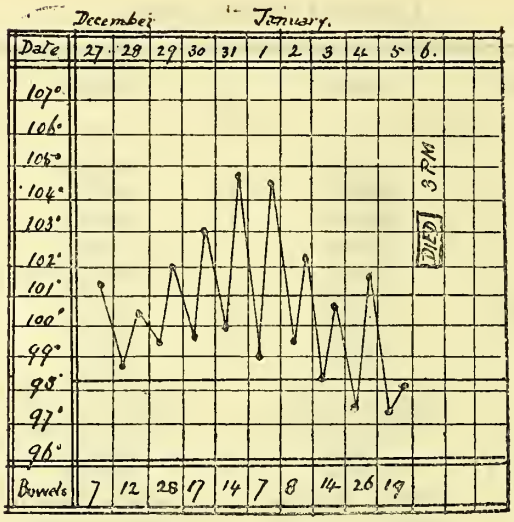
Bacillus A : Negative reaction.
Bacillus B : Negative reaction.
Bacillus C : Negative reaction.
Bacillus D : Negative reaction.
Bacillus E : Negative reaction.
Bacillus G : Negative reaction.

Remarks.—As remarked above, this case is very similar to the preceding one, but in a more advanced condition. Here ulceration has taken place to a considerable extent. Note as in No. 1 Case the nondescript character of the temperature curve. In this case also the organs and blood are sterile, as the few colonies of streptococci and micrococci found in the spleen may be left out of account. The bile in this case is swarming with bacillus coli, which may be supposed to have grown through from the closely applied large intestine, as 12 hours elapsed before the post-mortem examination.

Case 3.—Dysentery. Death after 11 days in hospital.

History.—Corporal Harrison, Army Post Office Corps, age 33, was admitted to No. 2 General Hospital, Pretoria, on December 27, 1900, and died on January 6, 1901. He was sent in from camp at Rietfontein, near Pretoria, and complained of having been in an unsatisfactory state of health for some months.

The following chart represents the course of the disease :—



Post-Mortem Examination.—1¼ hours after death.

The body was somewhat emaciated. On opening into the peritoneal cavity the coils of the small intestine appeared normal except for some slight appearance of congestion. There was no fluid in the cavity, and no signs of perforation or peritonitis. The lymphatic glands in connection with the large intestine were much swollen. The spleen was normal in appearance, and weighed 5 ozs. The liver was congested, but showed no signs of abscess formation. The heart and lungs presented nothing noteworthy.

Small intestine: There was some slight congestion of the mucous membrane near the ileo-cœcal valve, but no infiltration nor ulceration of Peyer's patches nor of the solitary glands.

The large intestine presented a peculiar appearance. It was not thickened throughout, but had patches of extreme infiltration and ulceration at several points. For example from the ileo-cœcal valve for a distance of 5 inches up the ascending colon there was a patch of this thickening. The mucous membrane and wall of the intestine were at this point quite ¾-inch in thickness. The surface was not only ulcerated, but also showed several large sloughs of mucous membrane, which were attached by one margin to the intestinal wall, while the other hung free in the lumen of the gut. Above this patch of thickening the wall of the large intestine was thinned and atrophied, with here and there small superficial ulcerations. This thinned portion of the intestine extended for 8 inches, when another area of extreme thickening was encountered. Here the infiltrated intestinal wall was covered with sloughs quite ½ an inch in thickness. This second thickened portion was again succeeded by another 8 inches of thinned and atrophied bowel, when another patch of extreme thickening about the size of a man's hand was met with. In the vicinity of the rectum the bowel was so much softened and ulcerated as to render its removal without tearing a matter of difficulty.

Microscopical Examination.—Cover-glass preparations of the heart's blood, spleen, and liver showed nothing abnormal.

Hanging-drop preparations from the large intestine showed no amœbæ.

Cultures from Organs.

Organ.	Tube.	1 day.	2 days.	7 days.
Spleen	1	Sterile	Sterile	Sterile
Spleen	2	Sterile	Sterile	Sterile
Spleen	3	Sterile	Sterile	Sterile
Liver	1	Sterile	Sterile	Sterile
Liver	2	Sterile	Sterile	Sterile
Bile	1	Sterile	Sterile	Sterile
Bile	2	Sterile	Sterile	Sterile
Heart's blood ..	1	Sterile	Sterile	Sterile
Heart's blood ..	2	Sterile	Sterile	Sterile

Serum Sedimentation.

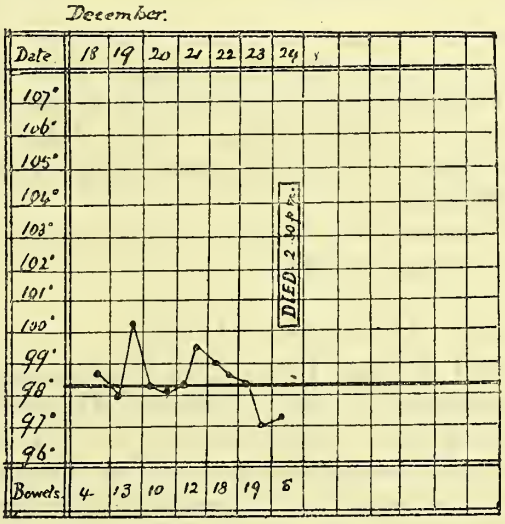
Bacillus typhosus, 1 in 10 : Negative reaction.
Bacillus A, 1 in 10 : Negative reaction.
Bacillus B, 1 in 10 : Negative reaction.
Bacillus C, 1 in 10 : Negative reaction.
Bacillus E, 1 in 10 : Negative reaction.

Remarks.—This is also a well-marked case of dysentery. Mark the process of ulcer formation by the separation of large sloughs of mucous membrane due to the necrosis of the underlying sub-mucous. The agar-agar tubes, inoculated from the organs, blood, and bile all remained absolutely sterile. The condition of the intestine is curious, and the temperature curve, although a little more definite, still shows nothing specific.

Case 4.—Dysentery : Death on or about the 8th day.

History.—Louis Ducovitch, Russian, was admitted to the Volks Hospital, Pretoria, on December 18, 1900, and died on the 24th. Dr. Thornton, the medical officer in charge, stated that he had been some eight days ill, with very severe symptoms of dysentery. The temperature is reported to have been sub-normal throughout. He had 15 to 20 fluid stools per diem with mucus and much blood.

The following chart represents the course of the disease :—



Post-Mortem Examination.—1½ hours after death.

The body was that of a very small, somewhat emaciated man of 30 years of age. There were no noteworthy external marks. On opening into the abdominal cavity the peritoneum was found to contain no fluid, nor were there any signs of peritonitis. The coils of small intestine showed no signs of disease, but the large intestine was injected, and could be felt to be much thickened.

The spleen was small, and normal in appearance. Weight 3 ozs.

The liver was healthy in appearance, and showed no signs of abscess formation.

The large intestine on being opened up presented all the appearances of acute dysentery. From the ileo-cœcal valve to the verge of the anus the intestine was one mass of infiltration, ulceration, putrefaction, and disorganisation. The floor of many of the ulcers showed the usual signs of hæmorrhage, being covered with black, shreddy, cobwebby material. The wall of the intestine was so much softened in many places that even while removing it with the greatest care it ruptured in places, and the coffee-ground grumous-like contents oozed into the peritoneal cavity. Nothing more need be add to this description except to note that the mesenteric glands in connecti with the large intestine were enormously enlarged. This intestine had a ve similar appearance to that found in Case 8.

Microscopical Examination —No amœbæ could be made out in preparations from the large intestine.

Culture from Organs.

Organ.	Tube.	1 day.	2 days.	7 days.
Spleen	1	Sterile	Sterile	Sterile
Spleen	2	Sterile	Sterile	Sterile
Spleen	3	Sterile	Sterile	Sterile
Liver	1	Sterile	Sterile	Sterile
Liver	2	Sterile	Sterile	Sterile
Heart's blood ..	1	Sterile	Sterile	Sterile
Heart's blood ..	2	Sterile	Sterile	Sterile
Mesenteric gland	1	Sterile	Sterile	Sterile
Mesenteric gland	2	Sterile	Sterile	Sterile
Bile	1	Small white colony	Many colonies	Many colonies
Bile	2	Small white colony	Many colonies	Many colonies

Species of Bacteria Cultivated from Organs.

Bile, Bacillus coli, var. A, and a micrococcus species unknown, called A.

Serum Sedimentation.

Bacillus typhosus, 1 in 10 : Negative reaction.
Bacillus A, 1 in 10 : Negative reaction.
Micrococcus A, 1 in 10 : Negative reaction.

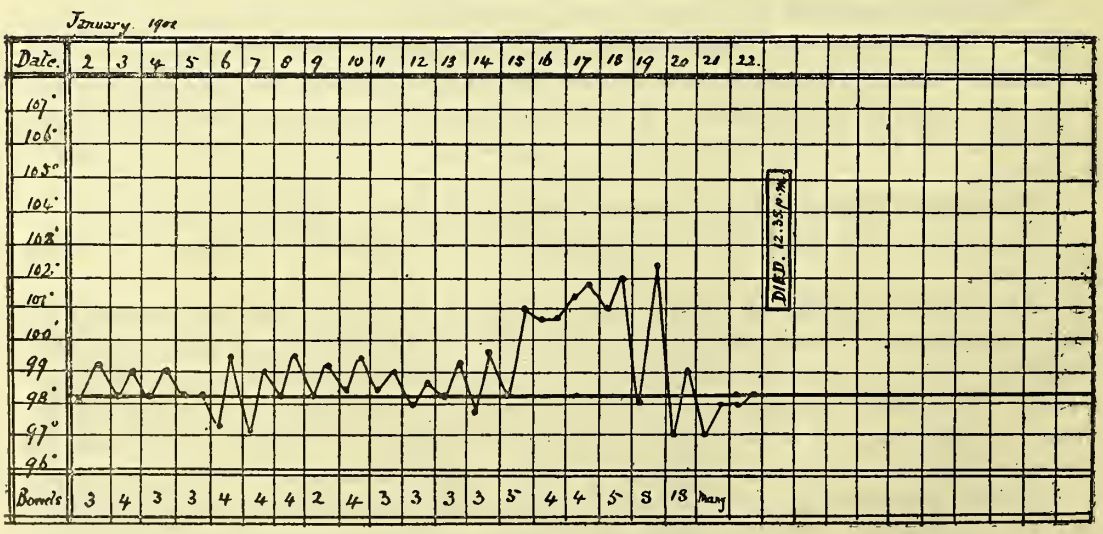
Remarks.—This is also a case of acute dysentery with a rapidly fatal termination. It is to be noted that the organs and blood are absolutely sterile in spite of the mass of putrefying material in the large intestine. It is difficult to account for the contamination of the bile. It may have been accidental, or perhaps due to the close proximity of the thin-walled gall bladder to the large intestine.

The temperature curve shows nothing of the very severe inflammatory processes at work in the large intestine.

Case 5.—Dysentery. Death after 31 days.

HISTORY.—No. 5614, Private Liscoe, 2nd Gordons, age 42, from the camp at Rustenburg, was admitted to No. 2 General Hospital, Pretoria, on November 20, 1900, suffering from rheumatism, he was discharged to the Convalescent Camp, Pretoria, on December 3, but was readmitted to No. 2 General Hospital on December 4 for orchitis. Dysentery supervened on December 22 while in hospital, and he died on January 22, 1901.

The following chart represents the course of the disease :—



Post-Mortem Examination.—1½ hours after death.

The body was that of a man in middle life, and was fairly well nourished. On making an incision from the chin and reflecting the parietes, the viscera appeared to be fairly normal in appearance. There was a small quantity of

clear serous fluid in the peritoneal cavity, but no signs of peritonitis or perforation. Both lungs were contracted, and there was little fluid in either pleural cavity. The pericardium contained a small quantity of clear straw-coloured serum.

Alimentary system: The lower part of the small intestine showed no signs of enteric lesions, there being no swelling or ulceration of Peyer's patches or the solitary glands. The walls of the intestine appeared to be thinned, and there was a considerable amount of reddening and congestion of the mucous membrane. Further, there was a peculiar roughening of the mucous membrane, caused by slight projections or tiny nodules coloured yellow by bile staining. This appearance seemed to be caused by a slight tumescence of the mucous follicles, each being surrounded by a ring of congestion, leaving the centre slightly raised, yellow and anæmic.

The large intestine presented the startling picture of advanced dysenteric disease. From the ileo-cœcal valve to the verge of the anus the intestine is thickened and ulcerated. From the point of view of a scheme of colour a diseased intestine such as this is striking. On a background of slatey green, reds, browns, and yellows are seen in every gradation of tint. The raised edges of the ulcer may be deep congested crimson, the margin pale necrotic yellow, and the centre dark brown bile-stained pigment. No healthy mucous membrane is to be seen throughout, only here and there a small island of greenish-coloured semi-necrotic tissue which represents its last remains. On placing such an intestine in water the whole surface is found to be covered with yellow, necrotic, irregular, ragged shreds of tissue which float up from the diseased surface.

The mesenteric glands of the large intestine were enlarged.

The liver was congested and two small abscesses the size of a pea were found in its substance.

The spleen was small and firm in consistence and only weighed 3½ ozs.

Microscopical Examination.—No amœbæ were detected in the intestinal contents.

Cultures from Organs.

Organ.	Tube.	1 day.	2 days.	7 days.
Spleen	1	Sterile	Sterile	Sterile
Spleen	2	Few white and yellow colonies	—	—
Spleen	3	Sterile	1 colony	1 colony
Spleen	4	1 colony	3 white colonies	3 white colonies
Spleen	5	Sterile	2 colonies	2 colonies
Liver	1	Sterile	Sterile	Sterile
Liver	2	Sterile	Sterile	Sterile
Liver abscess ..	1	Sterile	Sterile	Sterile
Liver abscess ..	2	Sterile	Sterile	Sterile
Bile	1	Copious growth	—	—
Bile	2	Copious growth	—	—
Heart's blood ..	1	Sterile	Sterile	Sterile
Heart's blood ..	2	Sterile	Sterile	Sterile
Intestine ..	1 and 2	Copious growth	—	—

Species of Bacteria cultivated from Organs.

Bile: Bacillus coli, var. B.
Spleen: Micrococcus B and bacillus coli, var. G.

Serum Sedimentation.

Bacillus A, B, D, E, F: Negative reaction.
Enteric bacillus: Negative reaction.

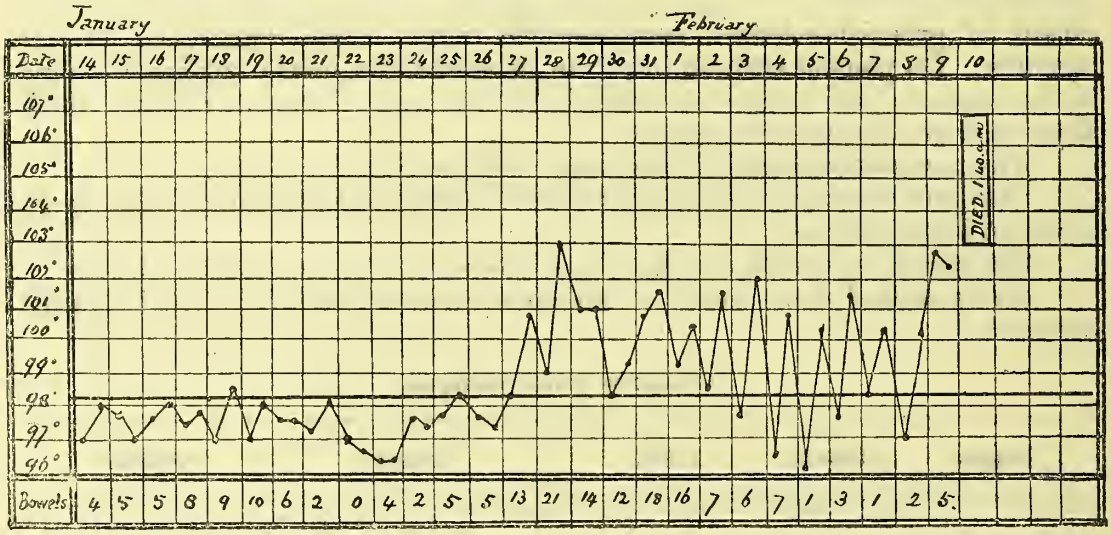
Remarks.—The spleen in this case may be looked upon as practically sterile as the few colonies which developed were probably extraneous. This then may be put down as another case of dysentery in which the organs were found to be free from bacteria. Why the bile again contains bacteria as in

Cases 2 and 4 I cannot explain. The large intestine in this case has evidently been the subject of the same pathological process as we have seen in Cases 1 and 2 but has advanced to a condition in which little or no mucous membrane is left.

Case 6.—Dysentery. Death about the 31st day.

History.—Private T. A. Shadlock, 2nd Norfolk Regiment, age 33, was admitted to No. 2 Model School Hospital on January 13, 1901, and died on February 10, 1901. This man, previous to his illness, had been living in the transport lines, near the Artillery Barracks. He came to Pretoria in August, 1900, and before that had been at the Orange River. From August to the beginning of January he lived in the Artillery Barracks and then was shifted to a tent in the transport lines. When asked if he blamed anything for his illness he complained of the smells in the camp due to urinals and latrines in the vicinity. His illness began three days before coming into hospital, where he suffered from diarrhœa. While in hospital he never complained of pain, but his frequent motions contained mucus, blood, feculent matter and undigested milk. It is also noted that the dejecta had a most offensive smell.

The following chart represents the course of the disease :—



Post-Mortem Examination.—7 hours after death.

The body was that of a man about 30 years of age and was well nourished, there being a thick layer of fat over the abdominal region. There was no fluid in the peritoneal cavity, but the coils of the intestine in the neighbourhood of the sigmoid flexure and rectum were adherent to the surrounding structures. The liver was seen to be much enlarged, and several abscesses show on its surface. The spleen was also enlarged. On opening into the thoracic cavity the lungs appeared healthy and there was no fluid in the pleural cavity. There was about 2 ozs. of straw-coloured serum in the pericardium and the heart appeared normal. On removing the large intestine it was found to be adherent to the abdominal walls in the lower part of the abdominal cavity. So adherent was the rectum and so disorganised by sloughing and ulceration, that it could not be removed except piecemeal. On opening up the large intestine, the cœcum, ascending colon, transverse colon, and the upper part of the descending colon were seen to be fairly normal in appearance. These parts of the large intestine show no signs of infiltration or ulceration. The mucous membrane of the cœcum was slate coloured due to some deposition of pigment. Higher up in the colon the mucous membrane was pale pink in colour with here and there a small patch of deeper congestion. The intestine at the sigmoid flexure was dusky red in colour and deeply congested. From the sigmoid flexure to the anus the gut was much thickened and the mucous and sub-mucous layers were in a gangrenous condition, ash grey in colour, and covered with sloughs which float up on immersion in water as ragged shreds.

In the small intestine the Peyer's patches in the vicinity of the ileo-cœcal valve were neither swollen nor ulcerated, but were somewhat pigmented and

presented a shaved-beard appearance. As one proceeded up the intestine there was found to be some congestion, and in the jejunum were also seen many small hæmorrhages about the size of hemp seeds and rather larger. These may not have been true extravasations of blood as they were more like globular dilatations on the veins.

The mucous lining of the stomach was deep dusky red towards its cardiac end and pale in the pyloric half.

Microscopical Examination.—Cover glass preparations of splenic pulp, bile and pus from a liver abscess, showed neither amœbæ nor bacteria.

The intestinal contents as usual showed a very extensive flora of bacteria and also a number of monads in active motion but no amœbæ.

Cultures from Organs.

Organs.	Tubes.	1 day.	2 days.	7 days.
Spleen	1	1 colony	2 colonies	2 colonies
Spleen	2	Many colonies	Many colonies	Many colonies
Spleen	3	16 colonies	Many colonies	Many colonies
Spleen	4	Many colonies	Many colonies	Many colonies
Spleen	5	10 colonies	Many colonies	Many colonies
Spleen	6	1 colony	2 colonies	2 colonies
Spleen Elsner ..	1	Sterile	Sterile	Sterile
Spleen Elsner ..	2	Sterile	Sterile	Sterile
Spleen Elsner ..	3	Sterile	Sterile	Sterile
Liver abscess ..	1	Sterile	Sterile	Sterile
Liver abscess ..	2	Sterile	Sterile	Sterile
Liver abscess ..	3	Sterile	Sterile	Sterile
Liver abscess ..	4	Sterile	Sterile	Sterile
Liver Elsner ..	1	Sterile	Sterile	Sterile
Liver acid glycerine agar	1	Sterile	Sterile	Sterile
Liver	1	Sterile	Sterile	Sterile
Liver Elsner ..	1	Sterile	Sterile	Sterile
Intestine ..	1	Copious growth	Copious growth	Copious growth
Intestine ..	2	Copious growth	Copious growth	Copious growth

Species of Bacteria cultivated from Organs.

Professor Simpson notes that he grew a bacillus from the intestinal mucus which gave all the reactions of the typhoid bacillus; he describes the bacilli as "large threads, with smaller bacilli, the latter slightly motile, the former not." This was probably bacillus G.

Two kinds of bacteria appeared in the tubes inoculated from the spleen and as neither had been previously met with a short description of each is given in order that their occurrence may be noted :—

Spleen No. 1.—A large micrococcus.
Broth: Uniformly cloudy. No pellicle. No indol reaction.
Gelatine slope: A pinkish yellowish growth along needle track.
Potato: Yellowish white growth
Milk: No coagulation.
Litmus agar-agar: Unchanged.
Sugar gelatine shake: No gas formation.

Spleen No. 2.—These colonies only appeared after 48 hours' growth at 37° C. and under the microscope the colonies were found to consist of ordinary-sized rods which after three days' growth contained many involution forms.

Broth: Slightly cloudy after four days. On the fifth a flocculent precipitate appeared leaving the broth clear. No pellicle. No indol reaction.
Agar-agar slopes: After two days a very faint transparent almost invisible growth, composed of innumerable pin-point colonies.
Potato: No growth.
Milk: Unchanged.
Gelatine slopes: No growth.
Sugar gelatine shake: No gas formation.

Serum Sedimentation.

Bacillus A, C, E, F, G: Negative reaction.
Bacillus typhosus: Negative reaction.

Remarks.—In this case the dysenteric process is restricted to a part of the large intestine, wherein it resembles Case 3 in which the dysenteric infiltration and ulceration were limited to a few patches.

Case 7.—Dysentery. Death after 21 days.

History.—No. 2975, Private A. Cox, 1st Connaught Rangers, was admitted to No. 2 General Hospital on October 29, 1900, suffering from symptoms of dysentery. He had been acting as orderly in this hospital when he was taken ill and was said to have been ill for a week before admission. The temperature was not taken regularly, but it is stated that as a rule it was below normal, and never went above 99° F. The principal symptom was stated to have been hæmorrhage, which was copious. He died on November 14, 1900, after an illness of about 21 days' duration.

Post-Mortem Examination.—4 hours after death.

The large intestine contained dark red glary fluid, and its lumen was contracted. On removing the intestine and opening it up the walls were found to be only slightly thickened. The mucous membrane was dark dusky red in colour, and this congestion was seen to pass up for some 5 feet of the small intestine. There were areas of ulceration throughout the large intestine and also parts, in one case some 10 inches in length, which appeared fairly normal.

Microscopical Examination.—Blood: Cover-glass preparations were stained in various ways and examined for the presence of malarial parasites and bacteria, but nothing abnormal could be detected.

Contents of large intestine: Preparations were made both of the liquid contents of the intestine and of scrapings from the floor of the ulcers. These were examined unstained on the warm stage, and also as fixed stained specimens. In these preparations multitudes of various shaped bacteria could be seen, but no appearance of amœbæ.

Microscopical Examination of Sections.—Fig. 1, Plate 4, represents a section of large intestine, stained by meth. blue, and magnified 10 times. This section is seen to comprise the three layers of the intestines, the sub-mucous layer is infiltrated and thickened and its blood vessels dilated. A small hæmorrhage is seen near the surface of the mucous membrane. Under a higher power large collections of red blood corpuscles are seen in the mucous membrane, as also in the sub-mucous layer. Under a magnification of 500 diameters the mucous membrane is found to be invaded by a very large number of rod-shaped bacteria, many indeed of the tubules appearing to be blocked up by the masses, the bacteria pass down as far as the muscularis mucosa layer but do not seem to invade the tissues beyond.

Mesenteric gland: No bacteria can be detected in these glands.

Liver: Some parts of the section of the liver in the vicinity of some abscesses are swarming with bacteria.

Cultures from Organs.

Heart's blood: White growth with formation of air bubbles.
Spleen: Slight white growth, no formation of air bubbles.
Liver abscess: White growth with formation of air bubbles.
Intestinal contents: Copious white growth.

Species of Bacteria Cultivated from Organs.

Blood: A liquefying, putrefactive bacillus.
Spleen: Bacillus coli, var. E.
Liver abscess: Bacillus coli, var. E and a liquefying, putrefactive bacillus.
Intestinal contents: Various species, among them many colonies of bacillus E and a liquefying, putrefactive bacillus.

Remarks.—This was the first case of dysentery which came under

(To face page 20)

Plate 4.

Fig 1

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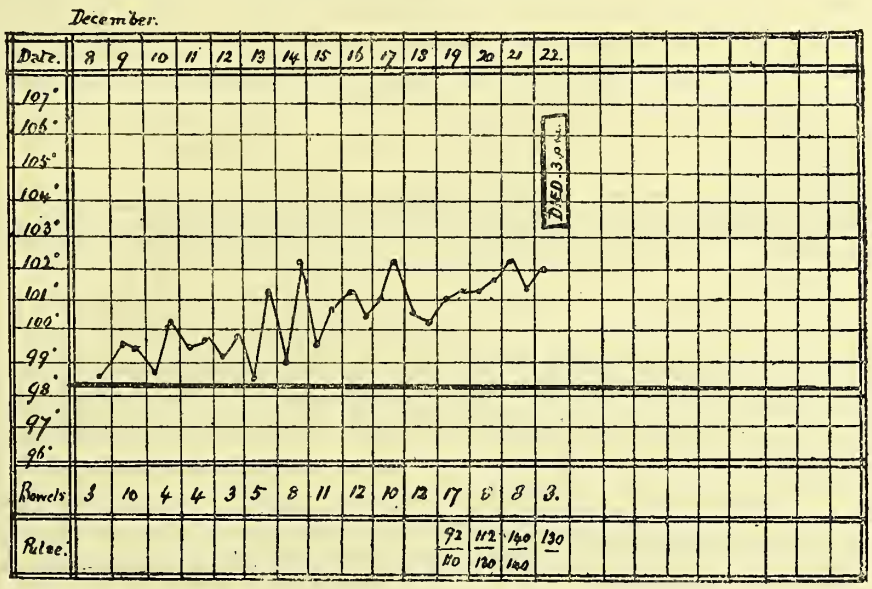
examination for the purpose of this Report. It is an unsatisfactory case and presents nothing noteworthy.

Case 8.—Dysentery and jaundice. Death 15 days after admission.

HISTORY.—Farrier-Sergeant J. N. Williamson, 3rd V.M.I., age 28, was admitted to No. 2 Model School Hospital, on December 8, 1900, and died on the 22nd. In addition to the ordinary severe dysenteric symptoms were jaundice, pain over gall-bladder, and painful micturition.

The following chart represents the course of the disease :—



Post-Mortem Examination.—$\frac{3}{4}$ hour after death.

The spleen was tough and fibrous in consistence but not enlarged.

The liver was cirrhotic and deeply stained with bile.

The peritoneal cavity contained a large quantity of grumous-looking fluid.

The large intestine was found to be perforated at four different points, which accounted for the peritonitis and purulent fluid in the peritoneum. On removing and opening up the large intestine it was found to contain a quantity of blood. There was great thickening of the walls especially in the cœcum and ascending colon. Almost the whole of the mucous membrane was in a state of putrid ulceration, the ulcers varying in size from 4 inches in diameter to $\frac{1}{2}$ inch and less. They were often seen to be extensively undermined and passed deeply into the tissues. The intestines was about $\frac{3}{4}$ inch in thickness and on cutting into this, cavities filled with yellow coloured debris were opened into. The floor of the ulcers was covered with black ragged looking material evidently due to hæmorrhages.

The small intestine showed nothing noteworthy.

Microscopical Examination.—In a small collection of pus scraped from one of the ulcers of the large intestine there were what appeared to be amœbæ in arge numbers.

Cultures from Organs.

Cultivations made from the spleen, bile, liver, and intestinal contents, all showed growth after 24 hours. This may be accounted for by the fact that perforation of the large intestine had occurred.

Species of Bacteria Cultivated from Organs.

Spleen : Bacillus A and micrococcus A.
Bile : Bacillus E.
Liver : Bacillus A and E.
Intestinal contents : Bacillus A and E.

Serum Sedimentation.

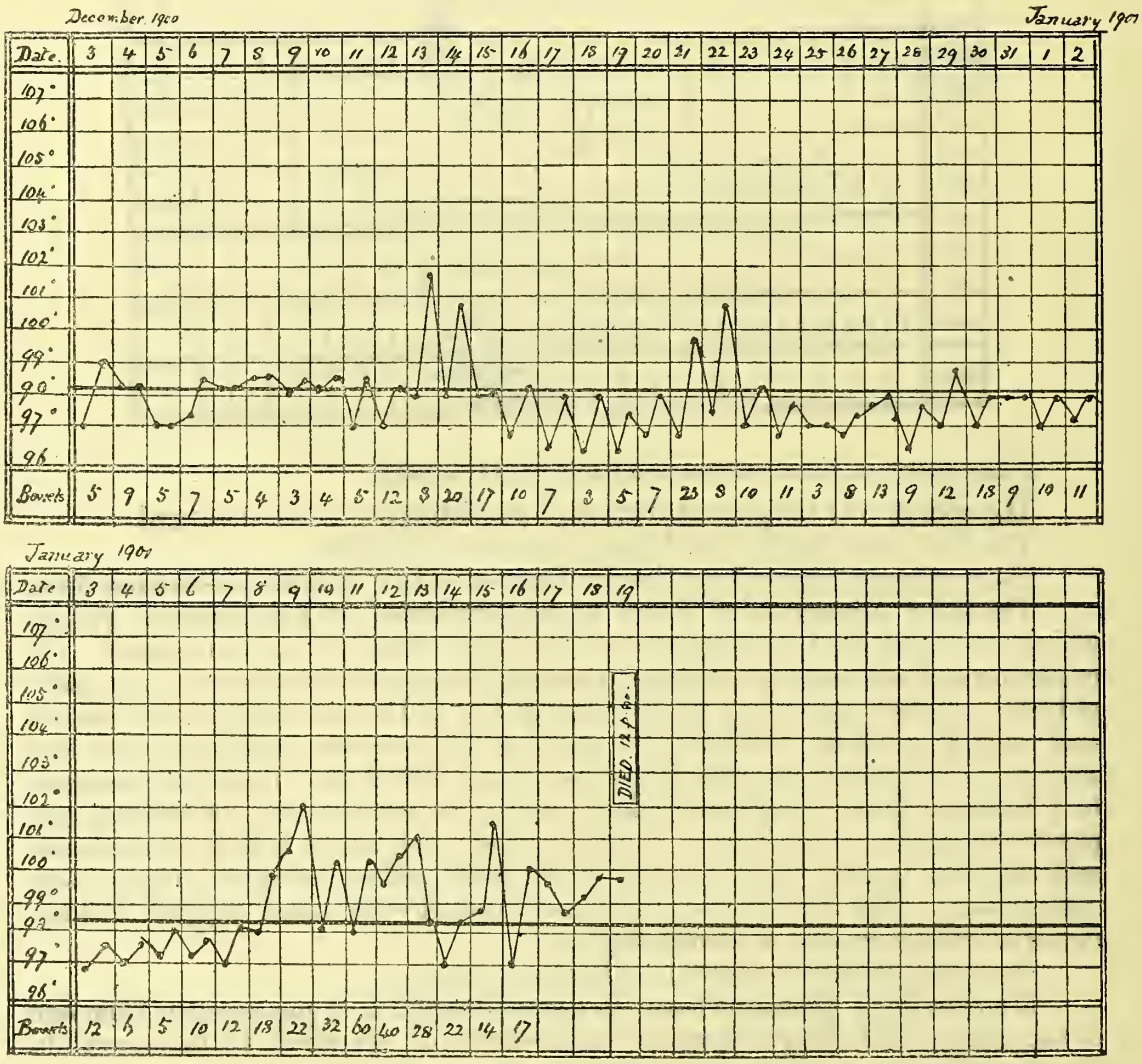
Bacillus typhosus, 1 in 10 : Negative reaction.
Bacillus A, 1 in 10 : Negative reaction.
Bacillus E, 1 in 10 : Negative reaction.
Micrococcus A, 1 in 10 : Negative reaction.

Remarks.—The large intestine in this case points to one mode of formation of dysenteric ulceration. The cavities filled with yellow coloured debris are due to necrosis and breaking down of the swollen sub-mucous layer. The sloughing of the mucous membrane over this cavity must shortly take place and the result will be the formation of a dysenteric ulcer

Case 9.—Dysentery. Death after 48 days.

History.—No. 6138, Private J. Carrol, R.M. Fusiliers, age 20, was admitted to No. 2 General Hospital, on December 2, 1900, suffering from dysenteric symptoms and died on January 19, 1901. His previous history was unknown. His symptoms while in hospital were constant abdominal discomfort latterly passing into actual pain. His motions were numerous and as a rule contained mucus streaked with blood. He was delirious at intervals.

The following chart represents the course of the disease :—



Post-Mortem Examination.—11 hours after death.

The body was much emaciated, rigor-mortis was present, there was marked lividity of the dependent parts, and a blue discolouration over the abdominal region.

No fluid was found in the peritoneal cavity or any in either pleural cavity. Both lungs collapsed normally and were fairly healthy in appearance. Spleen weighed 5 oz. The liver was fatty with chronic congestion and weighed 3 lb. 9 oz.

The lower part of the small intestine was reddened in patches and congested. Peyer's patches were congested but showed no enlargement or infiltration.

The large intestine from the ileo-cœcal valve to the anus was thickened and ulcerated. The general colour was slate. In the colon the ulcers appeared to run across the intestine transversely and were not undermined, but the ulcerated surface might be described as almost continuous as there was little or no mucus membrane left. In the rectum the ulcers were irregularly round,

almost confluent, the edges light yellow in colour and the floor covered with dirty yellow coloured slough, streaked with blackish coloured debris, evidently due to hæmorrhage.

Microscopical Examination.—Blood: Nothing abnormal.

Spleen: Nothing abnormal.

Contents of large intestine: Crowded with bacteria, no amœbæ.

Cultures from Organs.

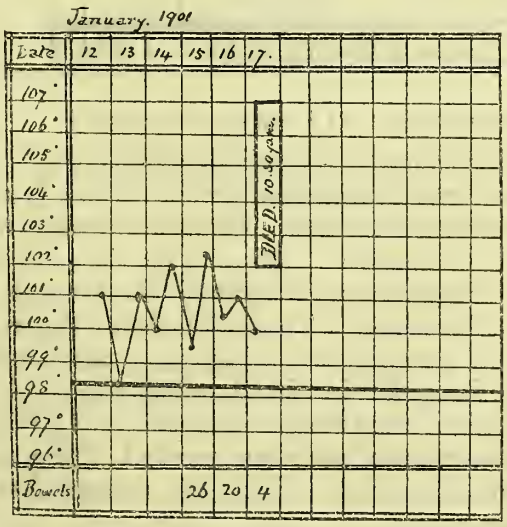
Organs.	Tubes.	1 day.	2 days.
Spleen	1	Sterile	1 colony
Spleen	2	9 colonies	9 colonies
Spleen	3	4 colonies	4 colonies
Liver	1	Many colonies	Many colonies
Liver	2	Many colonies	Many colonies
Bile	1	Sterile	Sterile
Bile	2	Sterile	Sterile

Remarks.—It is curious that in this case cultures from the bile remained sterile while those from the liver showed many growths. The spleen evidently does not contain many bacteria. The 11 hours the body lay in a warm atmosphere may account for the non-sterility of the liver and spleen, though it is difficult to account for the sterility of the bile. On account of pressure of work it was impossible to work out these colonies further.

Case 10.—Dysentery. Death on the 6th day.

History.—Private Patrick Verdon, 1st Australian Bushmen, age 32, was admitted to No. 7 General Hospital, Pretoria, on January 12, 1901, and died on the 17th. He came from the Rustenburg District and had been in hospital suffering, it was supposed, from acute rheumatism, but was convalescent when he was transferred to No. 7 Hospital three weeks ago. Here he developed symptoms of acute dysentery, with pain, straining and tenesmus and constant evacuations of blood and mucus. He died with symptoms of collapse after 6 days' illness partly due no doubt to his being weak and emaciated from his previous illness.

The following chart represents the course of the disease :—



Post-Mortem Examination.—17 hours after death.

Small intestine: Nothing noteworthy.

Large intestine: This was thickened and ulcerated throughout, and of a grey or slatey colour. The ulcers were shallow as a rule with undermined

edges and in many the muscular coat was exposed. The walls of the intestine were so much softened that it was with difficulty removed.

Microscopical Examination.—No amœbæ could be detected in preparations from the large intestine.

Cultures from Organs.

All the tubes inoculated from the organs of this case showed signs of growth.

Bacteria Cultivated from Organs.

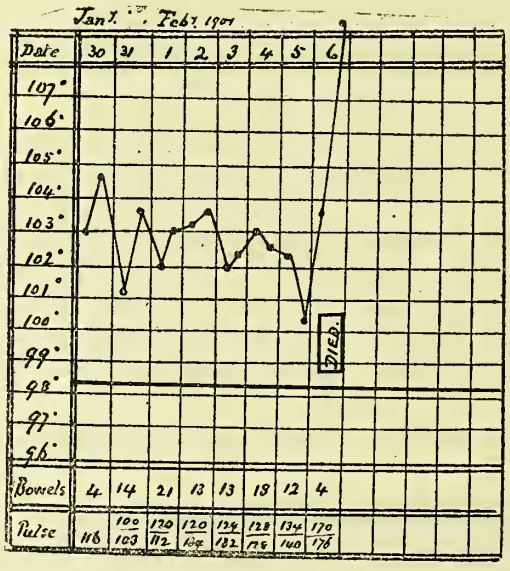
Spleen : Bacillus E.
Intestine : Bacillus E.

Remarks.—17 hours came between the death of this case and the post-mortem examination. During this time the body had been lying in a single bell tent and exposed to the excessive heat of a very hot midsummer day in Pretoria. On account of this the fact that the organs were not sterile is ignored.

Case 11.—Diagnosed enteric fever, on post-mortem examination found to be dysentery. Death on the 8th day.

History.—Private Powel, M.I., 1st South Staffordshire Regiment, age 22, was admitted to hospital on January 30, 1901, and died on February 6.

The following chart represents the course of the disease :—



Post-Mortem Examination.—1¾ hours after death.

Body fairly well nourished. A young-looking man.

The spleen was very much enlarged, soft, congested, and friable.

Small intestine : Reaction neutral. Healthy, except the lower part of the ileum which was slightly congested. Peyer's patches not conspicuous.

Large intestine : Congested and inflamed from cœcum to rectum. The cœcum was very much thickened. Three-fourths of the intestine was covered with a greenish mass of sloughs, the other part was maroon coloured. The ulcers were transverse, irregular in shape, edges deep red, the floor ash-grey and covered in parts with blackish-green debris. The inflammation of the large intestine below the cœcum was very marked. The sigmoid flexure was much congested but not thickened. Near the rectum there was a large ulcer in a sloughing condition.

Microscopical Examination.—Blood : No malarial parasites.

Cultures from Organs.

Organ.	Tube.	1 day.	2 days.	7 days.
Spleen	1	White colonies	White colonies	White colonies
Spleen	2	White colonies	White colonies	White colonies
Liver	1	Sterile	Sterile	Sterile
Liver	2	1 white colony	1 white colony	1 white colony
Bile	1	1 white colony	1 white colony	1 white colony
Heart's blood ..	1	Sterile	Sterile	Sterile
Large intestine..	1	Copious growth	—	—

Species of Bacteria Cultivated from Organs.

These were not worked out.

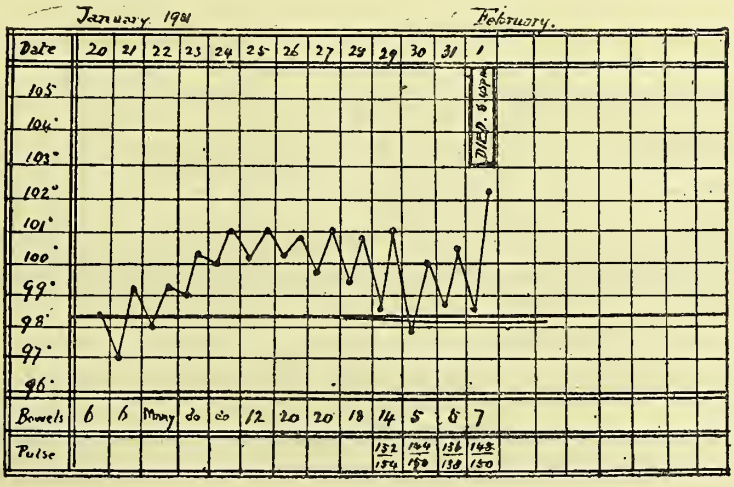
Serum Sedimentation.

Bacillus A : Negative reaction.
Bacillus C : Negative reaction.
Bacillus E : Negative reaction.
Bacillus F : Negative reaction.
Bacillus G : Negative reaction.

Case 12.—Dysentery : death after 27 days.

HISTORY.—No. 3925, Lance-Corporal A. Cooper, 2nd Norfolk Regiment, age 20, was admitted to No. 2 Model School Hospital, on January 20, 1901, suffering from dysenteric symptoms and died on February 1. He had been ill in barracks for 14 days before coming into hospital. He had had two previous attacks of dysentery in the country.

The following chart represents the course of the disease :—



Post-Mortem Examination.—5 hours after death.

The small intestine in its lower part was intensely congested and Peyer's patches were well marked and somewhat discoloured.

Cœcum : Pulpy, thickened, and covered with masses of black sloughs.

The whole of the large intestine was ulcerated throughout and may be described as a pulpy mass of ash-grey colour intermixed with green, but not thickened except at the rectum and cœcum, in fact some parts of the gut were very thin. The ulcers varied in size from a pea to half the circumference of the bowel and many were fringed with yellowish-white shreds surrounding a surface consisting of yellowish-grey sloughs.

Microscopical Examination.—Large intestine : Nothing noteworthy.

Species of Bacteria Cultivated from Organs.

Bacillus coli, var. E.

Serum Sedimentation.

Bacillus A, B, C, D, E, F, and G : Negative reaction,

Case 13.—Dysentery : Mild case. Recovery.

HISTORY.—No. 84060, Driver Gowing, R.H.A., age 28, was admitted to No. 2 Model School Hospital, Pretoria, on November 29, 1900, and transferred to base on December 22. He had been employed as an officer's servant, and arrived in Pretoria from Middleburg on November 20 after having been stationed there for two months. He stated that several of the R.H.A. suffered from dysentery while at Middleburg. He had no theory to account for these attacks, since in his opinion the food was good, and the water came from a clear running stream, which had all the appearance of a safe water supply.

He had been ill for the last 10 days, and during that time had had frequent motions, and had suffered severe pain in the abdominal region.

November 30.—Last night this patient passed many small dysenteric evacuations with much pain and tenesmus. The stools consisted of flakes of cloudy mucus suspended in a clear, transparent fluid and streaked with blood. There was total absence of feculence or feculent smell the fluid having merely a faint mawkish odour.

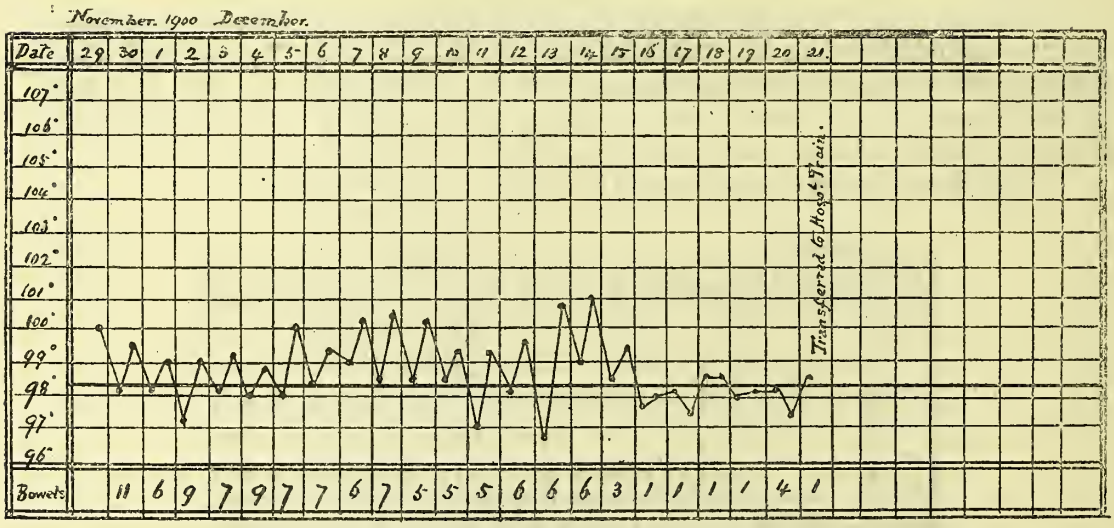
December 1.—Blood and mucus are still seen in the evacuations.

December 3.—The stools have become feculent in character, but the patient still complains of pain and tenesmus.

December 22.—Convalescent. Transferred to-day to the hospital train for conveyance to base.

This man will probably be invalided to England for change of climate.

The following chart represents the course of the disease :-



Microscopical Examination.—Specimens of intestinal mucus passed on November 30 and examined immediately on the warm stage showed no sign of amœbæ.

The mucus, dried and stained in the usual way, showed remarkably few bacteria. This was found to be the case as a rule in freshly made specimens from dejecta which exhibited no fæcal odour.

Bacteria Cultivated from the Intestinal Mucus.

Bacillus coli, var. A, B, C.

Serum Sedimentation.

Bacillus typhosus, 1 in 10 : Negative reaction.
Bacillus A, B, and E, 1 in 10 : Negative reaction.

Remarks.—This was a mild case of dysentery and presented no special features.

Case 14.—Dysentery : Mild case. Recovery.

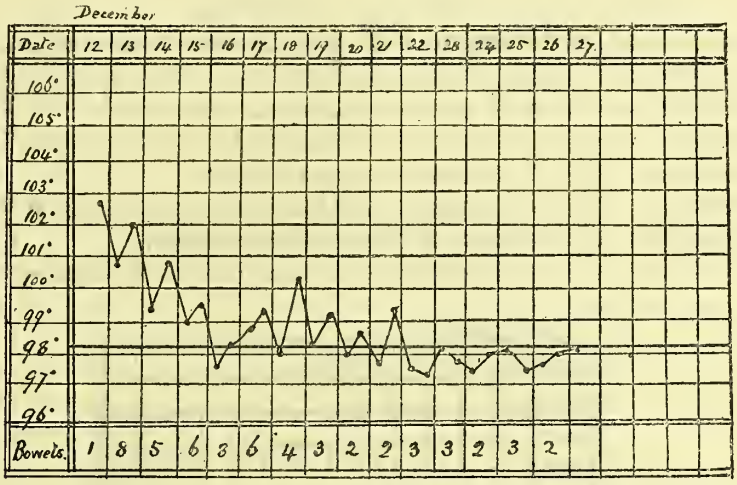
HISTORY.—No. 5216, Private W. Holtby, 2nd Lincolns, age 20, was admitted to No. 2 Model School Hospital, Pretoria, with symptoms of dysentery. He was attacked by this disease while stationed at the Dasspoort Camp, where he informed us there had been a good deal of dysentery. The food was

of the ordinary kind but the water supply was from the neighbouring stream and was anything but immaculate. He arrived in South Africa about a year ago and up to the present had had good health. This attack of dysentery began on December 10, 1900, and he was admitted to hospital on the 12th.

Symptoms: Pain in abdomen, frequency of call to stool, blood and mucus in stool, with straining and tenesmus.

December 13.—Stool this morning contained mucus, streaked with blood, microscopical and cultural preparations were made from it.

The following chart represents the course of the disease :—



Microscopical Examination.—Intestinal mucus: Just as in Case 13, only a few bacteria were seen scattered throughout the preparation and no signs of amœbæ.

Bacteria Cultivated from the Intestinal Mucus.

Bacillus A, D, and F.

Case 15.—Dysentery: Mild case. Recovery.

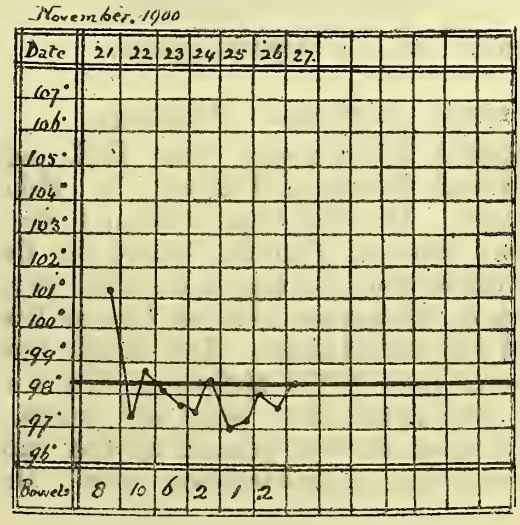
History.—No. 2681, Private J. Seaton, 2nd Lincolns, age 28, was admitted to No. 2 Model School Hospital, Pretoria, on November 21, 1900, suffering from symptoms of dysentery. He came from the camp at Dasspoort Pass, and stated that there had been several cases of dysentery there.

The food was fresh meat and compressed vegetables. The water was from the neighbouring stream and was used without being boiled.

The disease began about a week before admission to hospital, the chief symptoms being abdominal pain and the passage of blood and mucus in the stools.

November 23.—To-day the motions have a strong fæcal odour, and consist of clear glairy mucus, slightly blood-stained, and here and there a yellow or brownish tinge giving a suspicion of feculence.

The following chart represents the course of the disease :—



Microscopical Examination.—Blood: No malarial parasites. Nothing abnormal.

Intestinal mucus: Bacteria and spirilla very numerous. No amœbæ.

Bacteria Cultivated from the Intestinal Mucus.

Bacillus A, C, and E.

Serum Sedimentation.

Bacillus A, C, and E: Negative reaction.

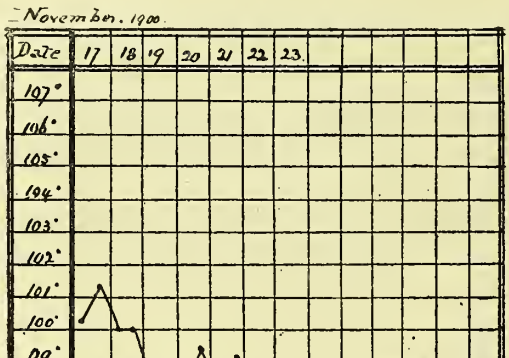
Case 16.—Dysentery: Mild case. Recovery.

HISTORY.—Sapper Johnston, R.E., age 19, was admitted on November 17, 1900, to No. 2 Model School Hospital, Pretoria, suffering from diarrhœa. He stated that there has been blood and mucus in his stools for the last three days, and he also stated that he was discharged from hospital at Bloemfontein three weeks before after an attack of enteric fever.

November 18.—Stools contain much mucus streaked with blood.

November 26.—Discharged to Convalescent Camp.

The following chart represents the course of the disease:—



Microscopical Examination.—The stools in this case on November 18 consisted mainly of clear jelly-like mucus tinged with blood. Hanging drop preparations were immediately made from this material and examined on the warm-stage. No amœbæ could be made out. In stained preparations of the same mucus, numerous bacteria were seen to be present.

Bacteria Cultivated from the Intestinal Mucus.

The majority of the colonies which grew on tubes of agar-agar inoculated with mucus from this case gave the cultural characteristics of bacillus E.

Serum Sedimentation.

Bacillus typhosus: 1 in 10; negative action.

Case 17.—Dysentery: Mild case. Recovery.

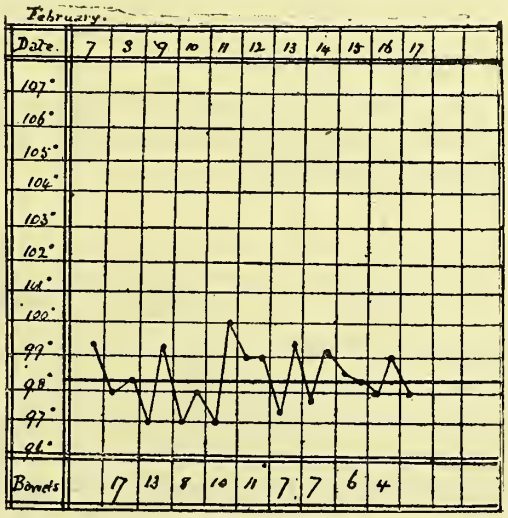
HISTORY.—Sapper A. E. Gastelow, 31st R.E., age 26, was admitted to No. 2 Model School Hospital, Pretoria, on February 7, 1901, with symptoms of dysentery. He had been stationed for the last two months close to the Railway Station, Pretoria, where he lived in a tent. His drinking water was taken from the tap on the main supply. He stated that he had had dysentery in November, 1899, at Orange River, and was attacked within a few days of his arrival there. The attack came on quite suddenly with pain in the lower part of the abdomen, with a straining sensation at the rectum and the motions contained blood and mucus. After he had been ill for three or four days he was present at the battles of Belmont and Graspan, being employed on a construction train. He had to run to any

part of the veldt when the bowels were to move, but later he was allowed to remain on the train. After these battles he went into the Orange River Field Hospital, and was there about 10 days when he was sent down to No. 2 General Hospital, Wynburg. The water of the Orange River was milky with sediment and although kept in a cistern it never became clear. This water was not boiled before use. There were not many dust storms while he was there. He had a comrade in the same company who was attacked at the same time, went into the Orange River Field Hospital, and died of dysentery at the Modder River. Sapper Gastelow was under treatment in the Wynburg Hospital for three months, and still suffered from diarrhœa for about two months after he went out of hospital. He then went north to Kimberley and Mafeking, after being there some time he was transferred to Barberton and arrived in Pretoria about two months ago. During the whole of this time he has suffered off and on from dysentery.

Present attack: Three or four days before admission he was attacked with diarrhœa, next day he found he was passing blood and mucus, and had pain across abdomen, great tenderness, the rectum feeling hot and burning, and it was as much as he could do to bear the pain. His tongue on admission to hospital was yellow, furred, with red tip and edges. There was great tenderness over the transverse colon, especially in the region of the splenic flexure. He laid the blame of this attack on an indiscretion in diet, consisting of a heavy meal of mixed pickles with vinegar and bread and cheese. He was attacked the following day. He had also been drinking a lot of water while at work in the I. M. Railway Workshops. He had not been out in the rain or on fatigue duty.

February 8.—To-day his motions consisted of mucus, blood, and serous fluid with here and there a trace of feculent matter, odour mawkish. Specimens of this mucus were taken for microscopical and cultural examination.

The following chart represents the course of the disease:—



Microscopical Examination.—Hanging drop: Many motile and non-motile bacilli; no appearance of amœbæ.

Stained specimen: Numerous bacteria of various shapes and sizes.

Bacteria Cultivated from Intestinal Mucus.

Bacillus B and various others which were not determined.

Serum Sedimentation.

Gastelow's blood gave a negative reaction with bacilli from eight different colonies grown from the intestinal mucus passed by him on February 8.

Gastelow's blood gave a positive reaction with bacillus F.

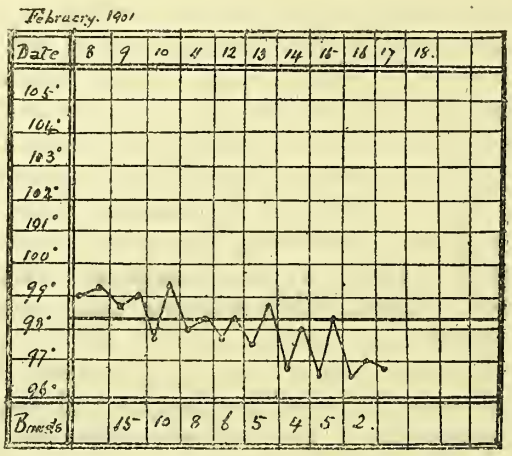
Gastelow's blood gave a negative reaction with bacillus A and B.

Case 18.—Dysentery: Mild case. Recovery.

History.—Private E. Essex, 2nd Hants, age 26, was admitted to No. 2 Model School Hospital, Pretoria, on February 8, 1901, suffering from

symptoms of dysentery. He had been quartered in the Johannesburg Redoubt, Pretoria, since Christmas. The water used was taken from a spring at the foot of the hill and was apparently of good quality. He suffered from an attack of enteric fever from June to September, 1900, but had never had any dysenteric symptoms previous to this illness. The principal symptoms were pain across the abdomen, and blood and mucus in the stools.

The following chart represents the course of the disease :—



Bacteria Cultivated from Intestinal Mucus.

Bacillus B.

Serum Sedimentation.

Bacillus A : Negative reaction.
Bacillus B ; Well marked reaction, 1 in 100.
Bacillus B : From Essex mucus, well marked reaction, 1 in 50.
Bacillus F : Negative reaction.
Bacillus typhosus : Negative reaction.

Remarks.—The chief interest in this case is that this man's blood serum gave a well marked reaction with Bacillus B, not only cultivated from himself but also from other cases of dysentery.

DESCRIPTION OF CASES OF ENTERIC FEVER EXAMINED.

Case 19.—Enteric fever : Death on the 8th day.

History.—No. 1565, Private E. Lait, 2nd Royal Berks, age 26, was admitted to No. 2 Model School Hospital, Pretoria, on November 22, 1900, and died on the 29th, with a suspicion of perforation.

The following chart represents the course of the disease :—

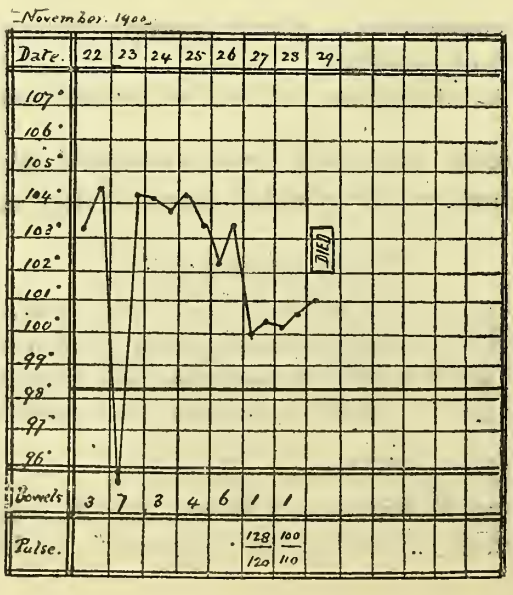


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Plate V.

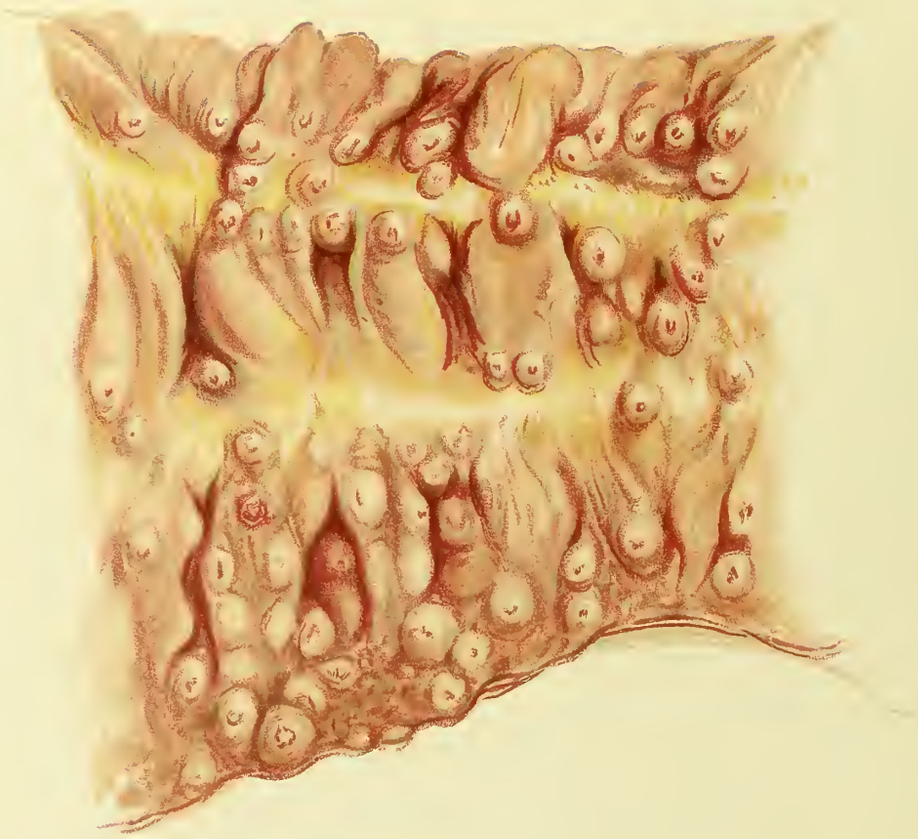

Fig. I.

1930. 5. 1902.

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Post-Mortem Examination.—This showed the characteristic lesions of a most severe and acute attack of enteric fever but without perforation. All the Peyer's patches in the last 6 or 8 feet of the small intestine were much infiltrated and several showed commencing ulceration. The large intestine was throughout studded thickly with enlarged solitary glands as represented in the sketch on the opposite page, Fig. 1, Plate V. This shows a pathological picture which in our experience is rare. It can readily be conceived that if this process went on to anything like extensive ulceration, a condition very similar to that found in cases of dysentery might readily occur. Compare more advanced cases such as Cases 24 and 25.

Serum Sedimentation.

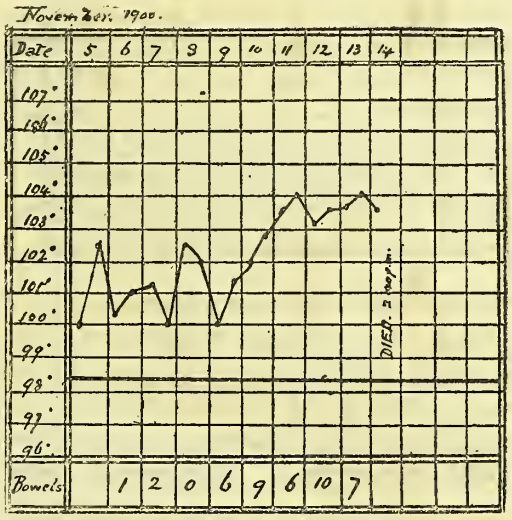
Bacillus typhosus: Negative reaction.

Here we have an example of blood serum taken after death from a case of acute enteric fever failing to give Widal's reaction with a test emulsion of enteric bacilli.

Case 20.—Enteric fever: Death after 10 days.

HISTORY.—No. 3190, Private J. Leary, 1st Royal Munsters, was admitted to No. 2 General Hospital, Pretoria, on November 5, 1900, suffering from enteric fever, and died on the 14th.

The following chart represents the course of the disease:—



Post-Mortem Examination.—1 hour after death.

Small intestine: There was some infiltration and swelling of the Peyer's patches situated at the lower end of the ileum, their edges being raised about an eighth of an inch above the general level. Several of these inflamed glandular areas also showed various degrees of ulceration.

Microscopical Examination.—Blood: Nothing abnormal.

Contents of intestine: Various bacteria; no amœbæ.

Cultures from Organs.

Spleen: The agar-agar tubes after 24 hours' growth at 37° C. showed many white colonies.

Species of Bacteria Cultivated from Spleen.

The white colonies put through the usual tests, prove to be pure cultivations of bacillus typhosus.

Serum Sedimentation.

Bacillus typhosus: 1 in 10; negative reaction.

Micrococcus melitensis: 1 in 10; negative reaction.

Remarks.—In this case there is nothing to be noted except that blood serum taken from this case as in Case 19 gives a negative reaction with a test emulsion of bacillus typhosus even at so low a dilution as 1 in 10. This seems to be the rule in acute, fatal cases of enteric fever, and of course, the

Serum Sedimentation.

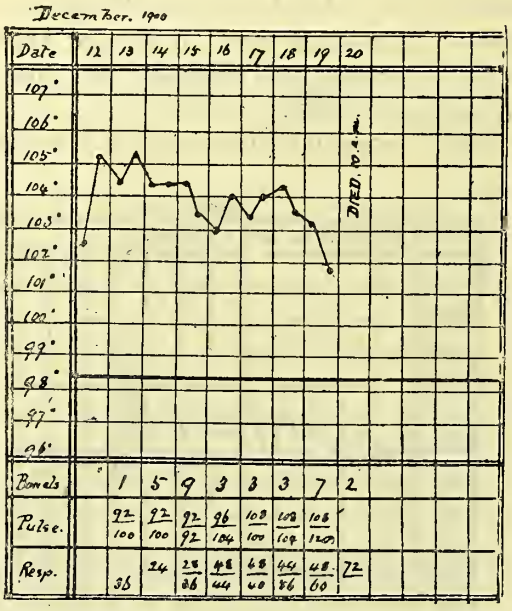
Bacillus typhosus: 1 in 20, positive reaction.

The typhoid bacilli, cultivated from the spleen and heart's blood of this case, gave with a test typhoid serum a positive reaction of 1 in 100.

Case 23.—Enteric fever. Death about the 8th day.

HISTORY.—Private J. Creedon, 1st Munster Fusiliers, age 21, was admitted to No. 2 Model School Hospital, Pretoria, on December 13, 1900, and died at 10 a.m. on the 19th.

The following chart represents the course of the disease :—



Post-Mortem Examination.—1 hour after death.

The small intestine showed many typical typhoid ulcers.

The large intestine appeared healthy.

Microscopical Examination.—Blood: Nothing abnormal.

Spleen: Cover-glass preparation showed groups of rods similar in size and shape to bacillus typhosus.

Contents of large intestine: Many forms of bacteria but no appearance of amœbæ.

Microscopical Examination of Sections.

Fig. 1, Plate VI, represents a section of the small intestine under a magnification of 10 diameters, and shows the ordinary typhoid infiltration and commencing ulceration.

Fig. 2 represents a section under the same conditions of magnification and staining of the large intestine. Here there is some congestion but no inflammatory exudation or ulceration.

Cultures from Organs.

Heart's blood: Sterile.

Spleen: Many white colonies.

Species of Bacilli cultivated from Organs.

Spleen: Pure cultivation of bacillus typhosus.

Serum Sedimentation.

This patient's serum, taken after death, gave with a test emulsion of bacillus typhosus a positive reaction of 1 in 100, and a negative reaction with higher dilutions.

Case 24.—Enteric fever followed by dysenteric symptoms. Death after 31 days.

HISTORY.—Private W. Wickham was admitted to No. 2 Model School Hospital, Pretoria, on October 29, 1900, and died on November 28.

(To face page 34)

Plate VI.

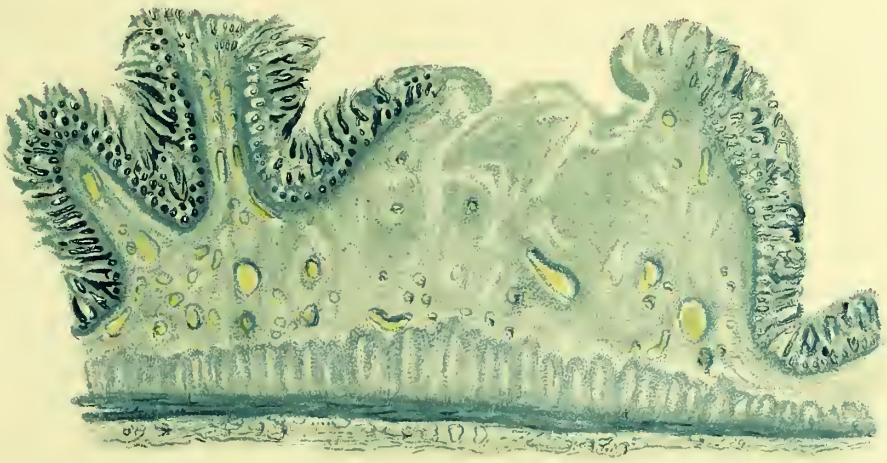


Fig. 1

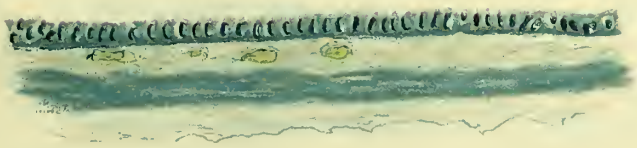


Fig 2

1930·5·1902

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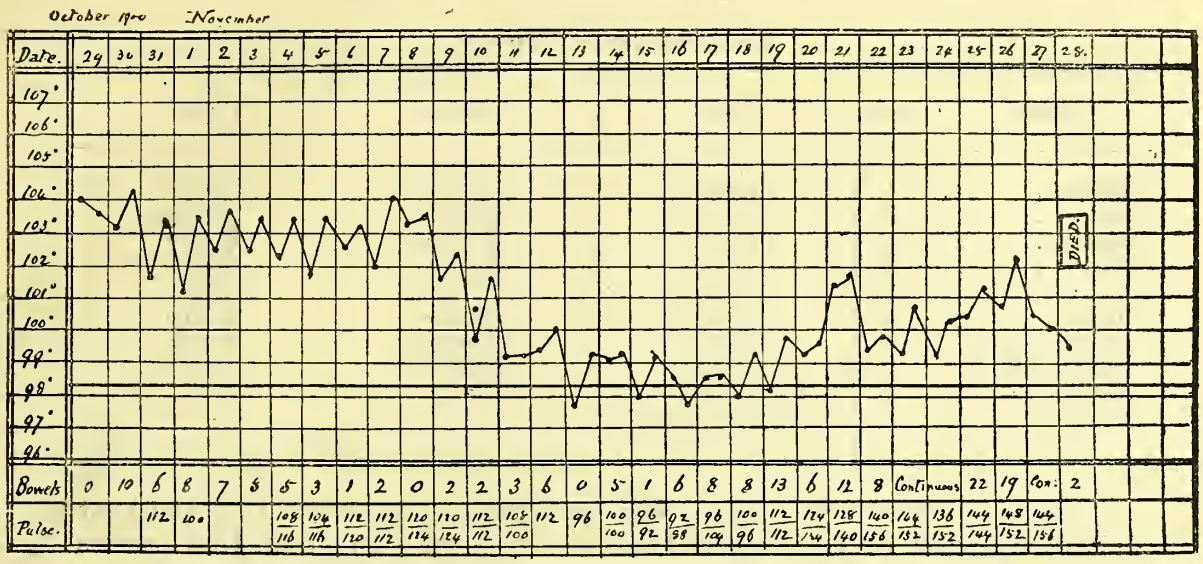
The following chart represents the course of the disease :—



Post-Mortem Examination.—2 hours after death.

The lower part of the small intestine was somewhat injected. The Peyer's patches near the ileo-cœcal valve were dark in colour as if pigmented. They were neither ulcerated nor markedly thickened, nor did they show any undermining of the edges. The surface of these patches seemed coarser-looking and rougher than the normal Peyer's patch, but whether this was due to the previous infiltration of the typhoid process or to mere continued congestion was impossible to determine. It can be said with certainty in this case there was no typical appearance of the typhoid process, no ulceration, no undermining of edges, which one would have expected to find in a case of this age.

Passing to the cœcum the mucous membrane was seen to be dusky red in colour and intensely inflamed ; the mucous membrane was perfectly smooth and there was no sign of ulceration. At the beginning of the ascending colon the mucous membrane was also intensely injected, but here the intestinal wall was also thickened and here and there were irregularly shaped worm-eaten-like ulcers. On the mucous membrane there were also noted many dark red spots about the size of a hemp seed, each with a yellow spot in the centre, evidently marking the site of commencing necrosis. Several of these breaking into each other evidently go to form the ragged-looking worm-eaten-like ulcerations.

The process is evidently an inflammatory infiltration of the solitary glands of the large intestine passing on to necrosis and ulceration from the centre outwards. The floor of some of these ulcers was greenish in colour and composed of necrotic tissue. None of the ulcers went deeper than the mucous and sub-mucous layers, and in none was the muscular layer exposed. Part of the ascending colon was fairly healthy, but the condition which obtained and was described in the ascending colon in the vicinity of the cœcum was found in the transverse colon, and became much exaggerated in the descending. The ulcers became much more numerous, preserved the same worm-eaten character, were very irregular in contour with swollen and somewhat overhanging margins. The ulceration did not seem to go much beyond the mucous membrane, but appeared deep on account of the thickened edges.

The floor of the ulcers was also formed as a rule of a greenish coloured necrotic material. As one neared the lower end of the intestine the ulceration became almost continuous, and in the region of the rectum the condition had reached its most exaggerated form. Here the wall of the intestine was greatly thickened, continuously ulcerated and covered with a greenish coloured necrotic, diphtheritic-like exudation.

Microscopical Examinations.—The contents of the large intestine and scrapings from the ulcers showed no signs of amœbæ.

Microscopical Examination of Sections.—Large intestine. Great numbers

of bacilli (rod-shaped) are seen scattered throughout the mucous membrane. Masses of them, especially at the bottom of the tubular glands.

Cultures from Organs.

Organ.	Tube.	1 day.	2 days.	7 days.
Spleen	1	Sterile	Sterile	Sterile
Spleen	2	Sterile	Sterile	Sterile
Spleen	3	Sterile	Sterile	Sterile
Liver	1	Sterile	Sterile	Sterile
Liver	2	Sterile	Sterile	Sterile
Liver	3	Sterile	Sterile	Sterile
Heart's blood ..	1	Sterile	Sterile	Sterile
Heart's blood ..	2	Sterile	Sterile	Sterile
Intestine ..	1	Copious growth	—	—
Intestine ..	2	Copious growth	—	—

These cultures were made on ordinary agar-agar nutrient jelly and kept in the incubator at the temperature of the blood. In order that species that might be present, but which resist growth on ordinary media, might be supplied with their natural pabulum, fairly large pieces of the organ were scraped up and placed on the surface. In spite of this, however, as will be seen from the table, all the tubes remained sterile.

Species of Bacteria Cultivated from Organs.

Mucus from intestine during life : Bacillus F.
Intestinal contents after death : Bacillus A and F.

Remarks.—This is an interesting case but one somewhat hard to interpret. It might in the first place be called a case of enteric fever from beginning to end. The ulceration in the large intestine would then be due to an extension of the enteric process. If we examine Case 19, we find there a condition of the large intestine which might readily be the forerunner of such a case as this. Against this interpretation we have the absence of any gross lesions in Peyer's patches, and the absence of the bacillus typhosus in cultivations from the spleen and liver. In the second place it might be a case of dysentery throughout. In favour of this would be the intense ulceration of the large intestine, the absence of ulceration in the small intestine, and the absence of typhoid bacillus in the organs. Or in the third place, it might be a case of dysentery following on enteric fever. In this case we would require to assume that the Peyer's glands had never been extensively implicated or had healed quickly, and also that the bacillus typhosus had disappeared rapidly from the organs. It is to be regretted that in this case no serum sedimentation test was made, as this would have supplied another factor towards the diagnosis. Taking into consideration the temperature curve, the fact that Peyer's patches were evidently the seat of some morbid process, and that the ulcerative process in the large intestine resembles more that found in enteric than in dysentery, we are inclined to think the diagnosis of this case is enteric fever throughout. At the same time it must be admitted that in all probability the extensive destruction of the mucous membrane of the large intestine has been largely aided and abetted in the later stages by bacteria other than bacillus typhosus.

Case 25.—Enteric fever followed by dysenteric symptoms. Death after 82 days.

History.—No. 1509, Private T. Martin, 4th New Zealand M.I., was admitted to No. 2 General Hospital, Pretoria, on October 14, 1900, suffering from symptoms of enteric fever, and died on January 4, 1901.

The following chart represents the course of the disease :—

(To face page 37.)

Plate VII

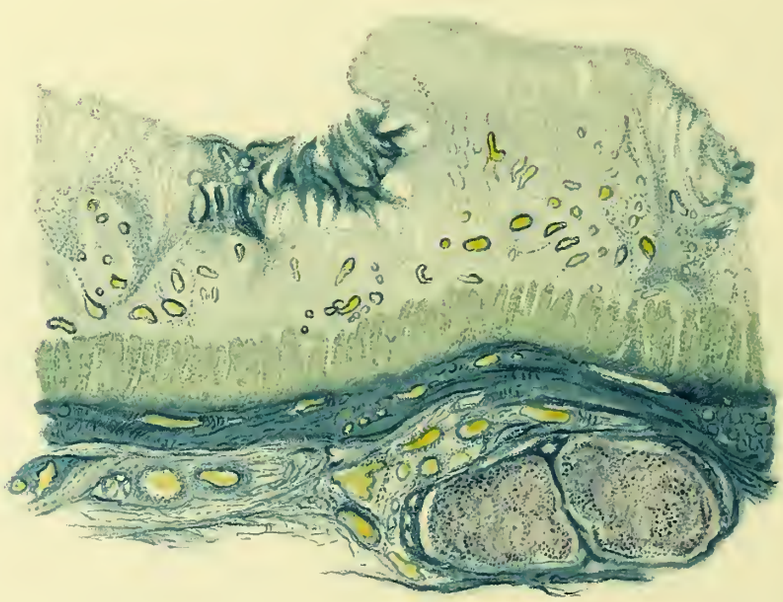


Fig. 1

1930·5·1902

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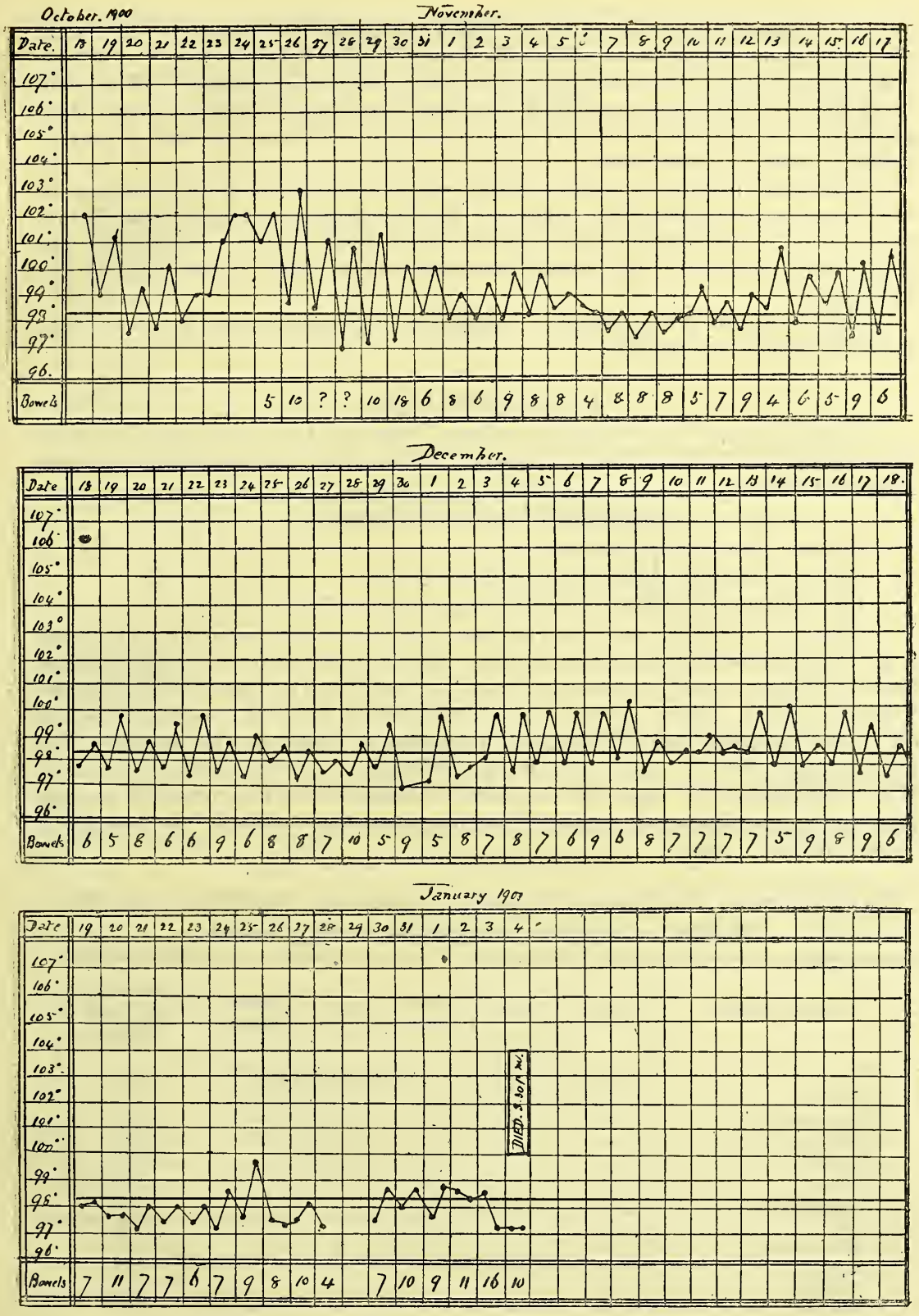


Post-Mortem Examination.—The body was extremely emaciated, being reduced to mere skin and bone. There was some green discolouration over the lower part of the abdomen and extreme lividity of dependent parts.

On opening into the body no spleen was found.

The spleen was not enlarged, was normal to the naked eye and weighed 5 ozs. The liver was congested. The lungs appeared healthy. The heart was small and atrophied, otherwise nothing noteworthy.

The mesenteric glands of the large intestine were much enlarged.

The large intestine was much thickened and cut as if of cartilaginous consistence. A microscopical section, Fig. 1, is represented on the opposite page, Plate 7. The general colour of the mucous membrane was a dark slate. From the ileo-cœcal valve to the rectum the whole of the intestine was ulcerated. Near the rectum there was very little mucous membrane left for a distance of about a foot, the primary ulcers having become confluent. Near the ileo-cœcal

valve the thickening of the intestine was very marked and many nodules were of an irregular shape stood out in the lumen of the bowel for fully a ½ inch. The ulcers were of all sizes and had a worm-eaten appearance. Many had their thickened margins coloured dark-red, and many of them had their margins slightly undermined. The floor of most of the ulcers had a greyish coloured sloughy appearance.

The small intestine was deep dusky-red at its lower end, and the mucous membrane was covered with numerous shallow ulcers varying in size from ½ to 1½ inch in diameter. These ulcers were weak-looking with eaten out edges, and their floor corresponded in colour to the general dusky-red of the intestines.

Microscopical Examinations.—Hanging drop preparations from the large intestine showed no amœbæ.

Cultures from Organs.

The agar-agar tubes from the spleen, liver and bile, all showed colonies growing on the surface after 24 hours. Those from the heart's blood alone remained sterile.

Species of Bacteria Cultivated.

Spleen : Bacillus typhosus.
Liver : Sarcina. Probably a contamination.
Bile : Proteus Zenkeri. Probably a contamination.

Remarks.—This is also like the preceding, a case difficult of interpretation. In Private Wickham's case there was no gross lesion of Peyer's patches found on post-mortem examination, and no bacillus typhosus was cultivated from the organs. Here, on the other hand, there is marked chronic ulceration of Peyer's patches and the bacillus typhosus is found in the spleen. The temperature chart in this case, unlike Wickham's is irregular and atypical. We are inclined to come to the same conclusion in this case as in the last, and to think the ulceration of the large intestine is due in the first place to the enteric process.

TABLE showing the Cases of Dysentery Examined after Death and the presence or absence of Bacteria in the Organs.

Case and Name.	Spleen.	Liver.	Liver Abscess.	Bile.	Heart's Blood.	Post-mortem after Death in Hours.
1. Maken	−	−		−	−	1
2. Thomason	−	−		+	−	12
3. Harrison	−	−		−	−	1
4. Ducovitch	−	−		+	−	2
5. Liscoe	−	−	−	+	−	2
6. Shadlock	+	−	−			6
7. Cox	+		+		+	4
8. Williamson	+	+		+		1
9. Carrol	+	+		−		11
10. Verdon..	+					17
11. Powel	+	−		−	−	2

From this table we would draw the conclusion that the organs in dysentery are, as a rule, sterile, agreeing in this with cholera, and differing from enteric fever. If this is so, then if there is a special micro-organism in dysentery it must be sought for in the large intestine, where we imagine the task of finding it will prove an arduous one.

TABLE showing the Cases of Dysentery Examined after Death and the kinds of Bacteria Cultivated from the Organs and Intestinal Contents.

Case and Name.	Spleen.	Liver.	Liver Abscess.	Bile.	Heart's Blood.	Intestinal contents.
1. Maken	—	—		—	—	A and B
2. Thomason	—	—		A	—	
3. Harrison	—	—		—	—	
4. Dukovitch	—	—		A	—	
5. Liscoe	G	—	—	B	—	
6. Shadlock	—	—	—			G
7. Cox	E		E			E
8. Williamson	A	A and E		F		A and E
9. Carrol	—	—		—		
10. Verdon..	E					E
11. Powel						
12. Cooper						E

TABLE showing the Cases of Dysentery Examined during Life and the kinds of Bacteria Cultivated from the Intestinal Mucus.

Case and Name.	Bacteria.					
13. Gowing	A	B	C	—	—	—
14. Holtby..	A	—	—	D	—	F
15. Seaton	A	—	C	—	E	—
16. Johnston	—	—	—	—	E	—
17. Gastelow	—	B	—	—	—	—
18. Essex	—	B	—	—	—	—

TABLE showing the Cases of Enteric Fever Examined after Death and the kinds of Bacteria Cultivated from the Organs.

Case and Name.	Spleen.	Liver.	Bile.	Heart's Blood.	Post-mortem Hours after Death.
20. Leary ..	B. typhosus				1
21. Ubsdell ..	B. typhosus and bacillus A.		B. typhosus		14
22. Sellick ..	B. typhosus	B. typhosus	B. typhosus	B. typhosus	4
23. Creedon ..	B. typhosus				1
24. Wickham ..	Sterile	Sterile		Sterile	2
25. Martin ..	B. typhosus				14

TABLE showing the Result of Serum Sedimentation Experiments in Cases of Dysentery.

Case and Name.	A.	B.	C.	D.	E.	F.	G.	Mic. A.	Mic. B.	Typ. B.
1. Maken	—	—				—		—		
2. Thomason ..	—	—	—		—	—	—			
3. Harrison ..	—	—	—	—	—	—		—		—
4. Ducovitch ..	—	—			—	—		—		
5. Liscoe	—	—	—	—	—	—	—	—		—
6. Shadlock ..	—	—	—		—	—	--	—		—
7. Cox										
8. Williamson ..	—	—			—	—		—		—
9. Carrol	—	—	—	—	—	—		—		—
10. Verdon										
11. Powel	—	—	—		—	—	—			
12. Cooper	—	—	—		—	—	—			
13. Gowing										
14. Holtby										
15. Seaton										
16. Johnston ..										
17. Gastelow ..	—	—				+				
18. Essex	—	+				—			—	
Chapman ..	—		—		—					
Baylin	—		—	—	—	—		—		
Thorne	—		—	—	—	—		—		
Murray	—		—	—	—	—		—		—
Elliot	—		—	—	—	—		—		—
Bisley	—		—	—	—	—		—		—
O'Donnell ..	—	—				—				
Dyer	—	—				—				
Williamson ..		—				—				
Blandford ..		—				—				
Eggers		—				—				
Jackson		—				—				
Bristowe ..		—				—				
Edie		—				—				
Roden		—				—				
Hobbs		—				—				
Trimmel		—				—				
McLean		—				—				
Bird		—				—				
Jacobs		—				—				

TABLE showing the Results of Serum Sedimentation Experiments in Cases of Enteric Fever.

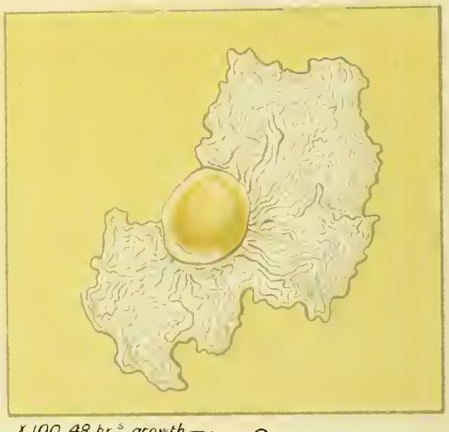
Serum from Enteric Cases.	1 in 10.	1 in 20.	1 in 50.	1 in 100.	1 in 200.	1 in 1,600.
Lait (death after 7 days)	—	—	—	—	—	—
Leary (death in 9 days)	—	—	—	—	—	
Ubsdell (death in 12 days) ..	+	+	+	+		
Sellick (death in 7 days)	—	—	—	—	—	
Creedon (death in 8 days) ..	+	+	+	+		
Wickham (death in 31 days) ..						
Martin (death in 82 days)	—	—	—	—	—	
Linton (during life)	+	+	—	—	—	
Mansfield (death 12th day) ..	—	—	—	-	—	
Brennan (death 27th day)	+	+	+	+		
Ridd (during life)	+	+	+	+	+	+

Plate 8.

Fig. 1

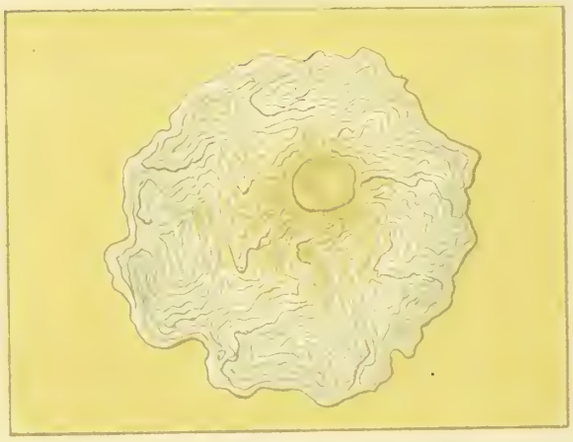
X 100 48 hr^s growth

Fig. 2



X 100 48 hr^s growth

Fig. 3



48 hrs growth

Fig. 4

7 days growth

Fig. 5

Fig. 6

Fig. 7

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DETAILED DESCRIPTION OF THE MICRO-ORGANISMS FOUND IN THE ORGANS AND INTESTINAL CONTENTS OF CASES OF DYSENTERY ABOVE DESCRIBED.

These bacilli are here grouped together as varieties of the so-called colon group, although the reason for this is not very evident to myself, except that they much resemble each other microscopically, as well as in their mode of growth, and pass by small gradations from Bacillus A, the bacillus coli communis type, to Bacillus G, at the end of the scale, which agrees in many respects with bacillus typhosus.

Bacillus A.

Micro-organism : These are short broad rods with rounded ends, about 1 μ. in breadth and 2 μ. in length. Examined in a hanging drop, it is difficult to say if they are motile or not. There is a certain amount of vibration of the rods which may be a feeble motility, but there is certainly no well-marked movement such as one sees in bacillus typhosus. These bacilli stain readily with any of the ordinary aniline stains, and many have the peculiarity of not taking on the stain at the ends, so that the stained rods have a truncated, square-ended appearance. (Fig. 1, Plate 8, magnified 1,500 diameters.)

Cultivations.—

Broth : After 24 hours the fluid is uniformly cloudy with no pellicle formation.

Gelatine plates : The colonies growing in the depth of the gelatine are round or oval in shape, with clear-cut edges, faintly greenish in colour by transmitted light, and almost perfectly smooth or very finely granular. When they reach the surface they expand irregularly into a bluish-white wavy transparent layer which extends about one-eighth of an inch from the centre. (Figs. 2, 3, 4, and 5, Plate 8.)

Gelatine stabs : After five days only a faint growth along the needle track, with a pale transparent expansion on the surface.

Gelatine slope : After five days a faint bluish-white growth along the path of the needle, spreading irregularly to some distance on the surface with an irregular fenestrated margin. (Fig. 6, Plate 8.)

Agar-agar slope : Grown in the incubator, shows a strong, slightly bluish-white expansion spreading regularly from the needle furrow. (Fig. 7, Plate 8.)

Potato : After 24 hours at the temperature of the blood, the surface is covered by a smooth, slimy yellowish coloured growth.

Milk (litmus) : Acid formation and coagulation. After some days the milk loses its red colour and becomes white, showing that the litmus has become decomposed.

Litmus agar-agar : After 18 hours reddened with much gas formation.

Sugar gelatine, shake : Rapid gas formation.

Indol reaction : Very marked after three days' growth in incubator, giving a deep pink colour to the broth on the addition of strong sulphuric acid.

Parietti broth : 4 per cent. shows distinct cloudiness after 24 hours at 37° C.

Bacillus B.

Micro-organism : These are short broad rods with rounded ends measuring on an average $\frac{1}{2}$ μ. in breadth and 1 μ. in length. (Fig. 1, Plate 9 ; magnified, 1,500 diameters.)

Cultivations.—

Broth : After 24 hours' growth uniformly cloudy with no pellicle formation.

Gelatine plates : After 48 hours the colonies in the depth of the gelatine are irregularly round, uneven, yellowish and finely granular on the surface spreading into bluish-white expansions. After several days the surface expansion is quite a quarter of an inch in diameter and still bluish-white in colour. (Figs. 2, 3, and 4, Plate 9.)

Gelatine stabs ; After a few days there is seen a marked white growth along the needle track, and on the surface a semi-transparent expansion.

Gelatine slope : Blue-white transparent film along needle furrow (Fig. 5).

Agar-agar slope : After 24 hours at 37° C. the surface is covered by a luxuriant white, smooth and shining growth (Fig. 6).

Litmus milk : Acid formation and coagulation. After some days the milk loses its red colour and becomes white.

Litmus agar-agar : Reddening with much formation of gas.

Sugar gelatine, shake : Rapid gas formation.

Indol reaction : After three days' growth in incubator, the broth shows no appearance of pink colouration on the addition of a trace of nitrite and strong sulphuric acid.

Parietti broth : 3 per cent. shows cloudiness after 24 hours at 37° C.

Plate 9.

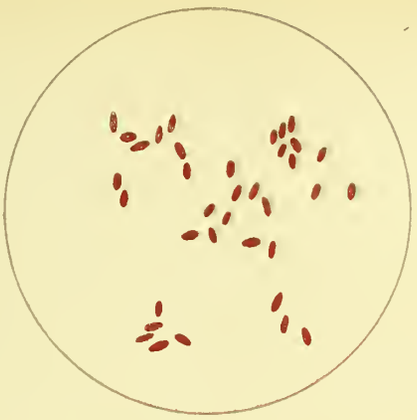
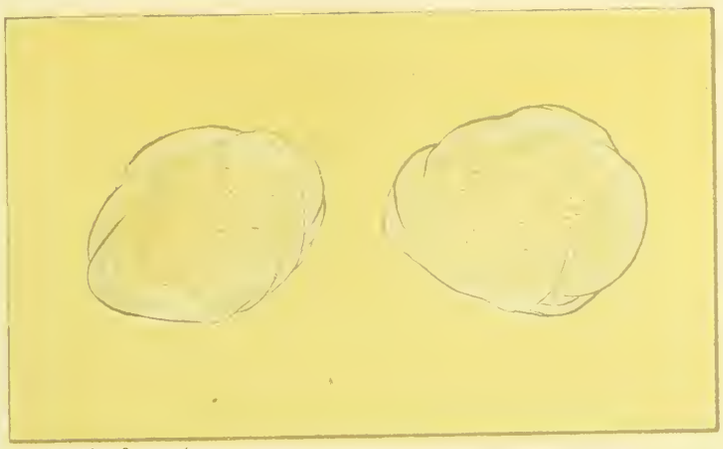
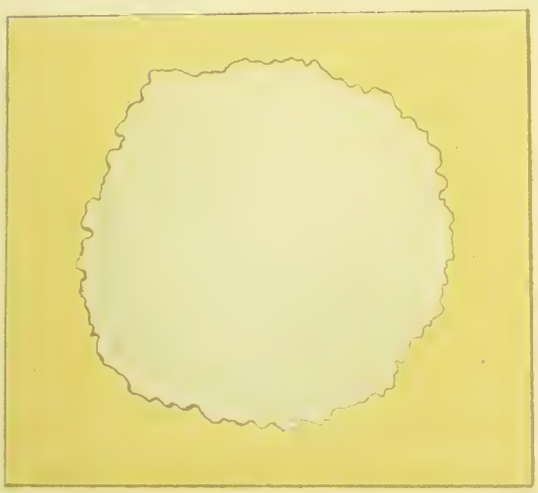


Fig. 1



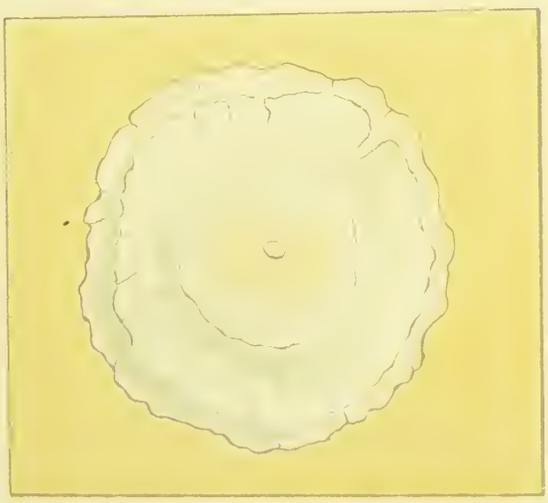
X 100 48 hrs growth

Fig. 2



48 hrs growth

Fig. 3



7 days growth

Fig. 4

Fig. 5

Fig. 6

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Plate 10.

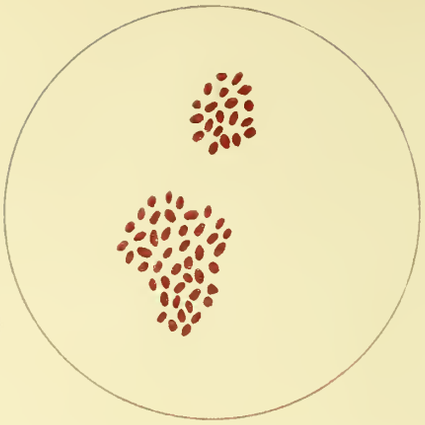
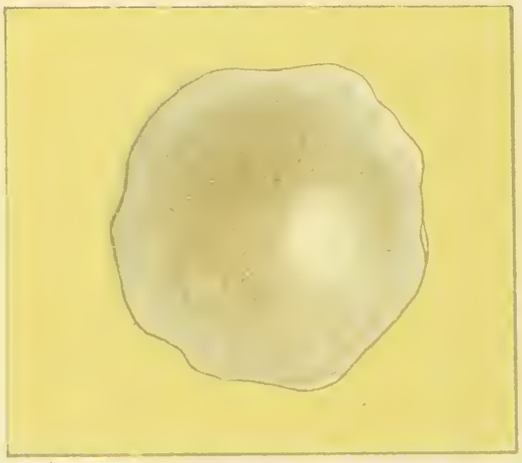


Fig. 1.

x 100. 48 hrs growth

Fig. 2.



48 hrs growth

Fig. 3.

7 days growth

Fig. 4.

Fig. 5.

Fig. 6.

Bacillus C.

Micro-organism : Round, oval, or short broad non-motile rods with round ends. (Fig. 1, Plate 10 ; magnified 1,500 diameters.)

Cultivations.—

Broth : After 24 hours' growth the fluid is uniformly cloudy with no pellicle formation.

Gelatine plates : After 24 hours the colonies in the depth of the gelatine are irregularly round in shape, yellowish-brown in colour, and very faintly granular in texture (Fig. 2). On the surface they spread slightly (Fig. 3). After seven days the colonies on the surface are about the size of buckshot, are raised above the surface, yellowish in the centre and white at the edges. Some of the small colonies grow up above the surface like minute rhinoceros horns (Fig. 4).

Gelatine stabs : After a few days there is seen a meagre white growth along the needle track, with a thick tenacious growth on the surface, extending to a short distance from the point of entrance of the needle. After several days there is a strong white growth on the surface, reaching half-way to the margin, flat and round with fairly even edge.

Gelatine slope : Strong opaque dead white growth (Fig. 5).

Agar-agar slope : Pure white-marked growth spreading on the surface (Fig. 6).

Potato : After 24 hours a shining buff-coloured growth. After three days a strong cream-coloured layer on the surface.

Litmus milk : Acid formation and coagulation. After some days the milk loses its red colour and becomes white.

Litmus agar-agar : Reddened in 24 hours ; again becomes blue in colour after three days and finally loses all colour.

Sugar gelatine : Copious gas formation.

Indol reaction : Negative.

Parietti broth : Growth in 3 per cent.

Bacillus D.

Micro-organism : Rods of medium size with rounded ends. When stained, the centre of the rod alone takes on the stain, the poles remaining unstained. Fig. 1, Plate 11 ; magnified 1,500 diameters.

Cultivations.—

Broth : After 24 hours, uniform turbidity. No pellicle formation.

Gelatine plates : After 48 hours the colonies in the depth of the gelatine are small, irregularly round, pale yellow, almost colourless, and very slightly granular, on the surface spreading out as a bluish-white expansion about the size of a No. 5 shot. (Figs. 2, 3, and 4.)

Gelatine stab : Meagre growth along needle track with faint growth on surface.

Gelatine slope : Faint bluish-white transparent growth. (Fig. 5.)

Agar-agar slope : Faint transparent growth. (Fig. 6.)

Potato : After three days a bright yellow growth.

Litmus milk : After 24 hours unchanged. After three days faintly reddened. No coagulation.

Sugar gelatine, shake : Copious gas formation.

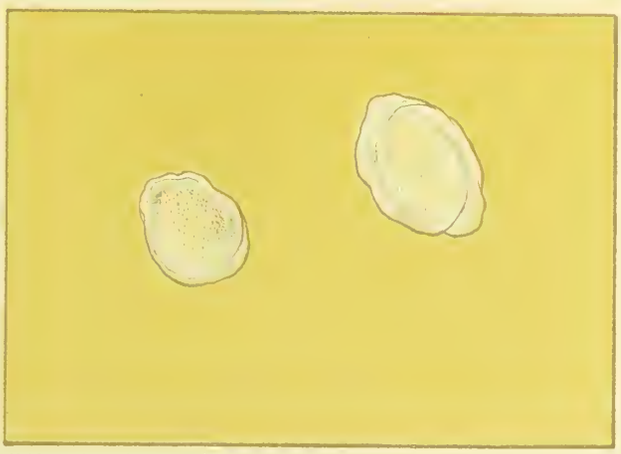
Indol reaction : After three days pale pink reaction.

Parietti broth : Growth in 4 per cent.

To face page 44.
(Bac D.)

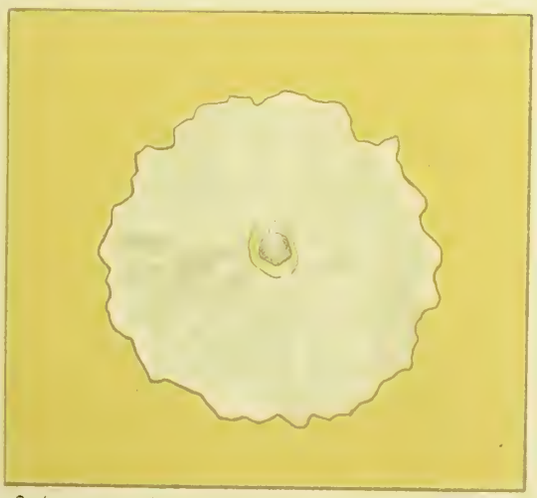
Plate II.

Fig. 1.



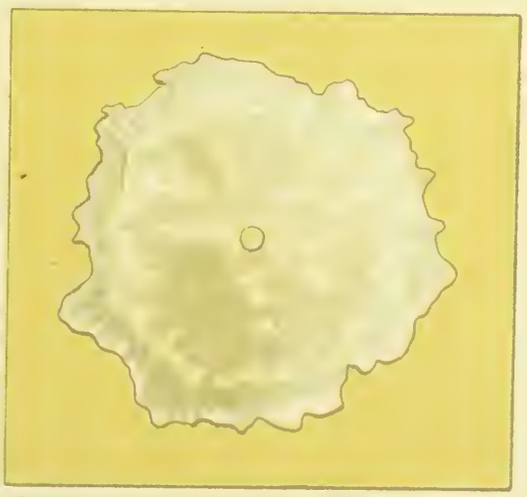
X 100. 48 hrs growth

Fig 2



2 days growth

Fig 3.



7 days growth

Fig 4

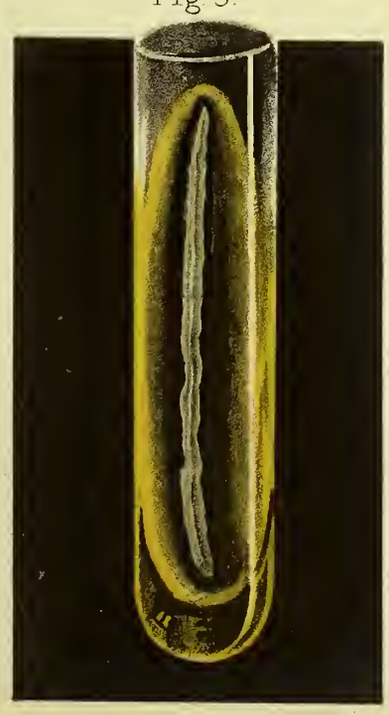


Fig. 5.

Fig. 6.

Plate 12.

Fig. 1

X100 48 hrs

Fig. 2

2 days

Fig. 3

7 days.

Fig. 4

Fig. 5

Fig. 6

Bacillus E.

Micro-organism: These are short, broad rods with rounded ends (Fig. 1, Plate 12), as a rule two or three times as long as broad, but often so short as to be oval or almost round in shape. These are non-motile. They stain readily in any of the ordinary aniline dyes, and become unstained by Gram's method.

Cultivations.—

Broth: At the end of 24 hours the fluid is uniformly cloudy, but even after several days there is no pellicle formation.

Gelatine plates: After 48 hours' growth the colonies in the depth of the gelatine are seen to be pale yellow in colour, granular, and in shape irregularly round, oval, or egg-shaped. On reaching the surface they spread out slightly as a faint transparent layer which gradually thickens at its centre. After seven days the colonies are still small, not larger than a No. 16 shot, and are white, shining, convex, porcelain-like. (Figs. 2, 3, and 4.)

Gelatine stab: After a few days there is a faint white growth along the needle track, and on the surface a small white expansion. After a few weeks there is a strong white growth to end of needle track, and on the surface a milky-white shining growth.

Gelatine slope: After some days a marked white opaque growth spreading about one-eighth of an inch from the needle furrow. (Fig. 5.)

Agar-agar slope: A marked growth, pure white in colour, spreading on the surface with irregular serrated margins. (Fig. 6.)

Potato: This bacillus grows well on this medium, and forms a pale yellow, almost grey, shining expansion.

Litmus milk: There is slight reddening of the litmus, but no coagulation of the milk.

Litmus agar-agar: Acid formation.

Sugar gelatine, shake: After 24 hours there is marked formation of gas.

Indol reaction: Broth cultures kept at 37° C. for several days show no indol reaction on the addition of a trace of nitrite of potassium and strong sulphuric acid.

Parietti broth: Broth containing 4 per cent. Parietti fluid shows distinct cloudiness after 24 hours in the incubator.

Bacillus F.

Micro-organism : Medium-sized rods with rounded ends. (Fig. 1, Plate 13; magnified 1,500 diameters.)

Cultivations.—

Broth : After 24 hours, uniform turbidity. No pellicle formation.

Gelatine plates : After 48 hours the colonies in the depth of the gelatine are still very small, irregularly round, pale yellow, almost colourless, very slightly granular, and with clear cut edges. On reaching the surface the colonies spread out as faint, bluish-white semi-transparent expansions, which after a week have attained the size of No. 4 shot. (Figs. 2 and 3.)

Gelatine stabs : After some days the growth along the needle track is meagre, and there is a faint, transparent growth on the surface.

Gelatine slope : After three days, blue-white, transparent, delicate. (Fig. 4.)

Agar-agar slope : A faint transparent growth. (Fig. 5.)

Potato : After three days a slight transparent glassy growth on surface.

Litmus milk : After 24 hours no acid formation ; after three days slight reddening, no coagulation.

Litmus agar-agar : A faint reddening after four days.

Sugar gelatine, shake : No gas formation.

Indol reaction : Negative.

Parietti broth : Growth in 3 per cent.

Plate 13.

Fig. 1

X100 48 hrs

Fig. 2

7 days

Fig 3

Fig. 4

Fig. 5

(To face page 47)
Bac. G.

Plate 14.

Fig. 1

X 100 48 hrs

Fig. 2

7 days.

Fig. 3

Fig. 4

Fig. 5

Bacillus G.

Micro-organism : Small fine rods. (Fig. 1, Plate 14 ; magnified 1,500 diameters.)

Cultivations.—

Broth : After 24 hours, uniformly turbid. No pellicle formation.

Gelatine plates : After 48 hours, small, irregularly round, colourless, finely granular colonies, spreading slightly on the surface into a whitish expansion. (Figs. 2 and 3.)

Gelatine stabs : After several days some slight growth along needle track and a faint transparent layer on the surface.

Gelatine slope : Bluish-white, transparent, extending for a short distance to either side of the needle furrow. (Fig. 4.)

Agar-agar slope : After three days a strong white growth on the surface. (Fig. 5.)

Potato : The film on the surface is faint pale and meagre.

Litmus milk : Unchanged.

Litmus agar-agar : Unchanged.

Sugar gelatine, shake : No gas formation.

Parietti broth : Growth in 3 per cent.

Micrococcus A.

Micro-organism : Small micrococcus. (Fig. 1, Plate 15 ; magnified 1,500 diameters.)

Cultivations.—

Broth : Uniformly cloudy. No pellicle.

Gelatine plates : After some days the colonies in the depth of the gelatine are still very minute, irregularly round or oval in shape, pale, transparent, and faintly granular. When they reach the surface they spread out to a slight extent as a white, smooth-edged delicate film. (Figs. 2 and 3.)

Gelatine stabs : Faint growth along the needle track. No perceptible surface growth.

Gelatine slope : Very faint, transparent, narrow, growth along the needle furrow, having somewhat the appearance of a fine cotton thread. (Fig. 4.)

Agar-agar slope : Faint, pale, bluish-white, narrow line, with an indistinct serrated margin. (Fig. 5.)

Potato : White, meagre growth.

Milk, litmus : Acid formation and coagulation.

Sugar gelatine, shake : No gas formation.

Indol : No reaction.

Parietti : 3 per cent.

Recapitulation of Characters.

Bac.	Micro-organisms.	Broth.	Gelatine Plates.
A	Rods, medium size, round ends, non-motile or feebly motile, poles often remain unstained	Uniformly cloudy. No pellicle	In depth, finely granular, round or oval. On surface, irregular, wavy, flat, bluish-white, transparent film
B	Rods, medium size, round ends, non-motile	Uniformly cloudy. No pellicle	In depth, finely granular, irregularly round. On surface, large bluish-white, terraced expansions
C	Round, oval, short rods, round ends, non-motile	Uniformly cloudy. No pellicle	In depth, finely granular, irregularly round. On surface, small, convex, raised above surface, yellow at centre, white edges, terraced, many like minute rhinoceros horns
D	Rods, medium size, round ends, non-motile, poles often remain unstained	Uniformly cloudy. No pellicle	In depth, finely granular, irregularly round. On surface, moderate size, bluish-white, semi-transparent, flat
E	Rods, medium size, round ends, non-motile	Uniformly cloudy. No pellicle	In depth, granular, irregularly round. On surface, small, white, shining, convex, porcelain-like
F	Rods, medium size, round ends, non-motile	Uniformly cloudy. No pellicle	In depth, finely granular, irregularly round. On surface, small, white, semi-transparent, flat
G	Small, fine rods, non-motile	Uniformly cloudy. No pellicle	In depth, finely granular, irregularly round. On surface, small, bluish-white, pale, semi-transparent, flat

Plate 15.

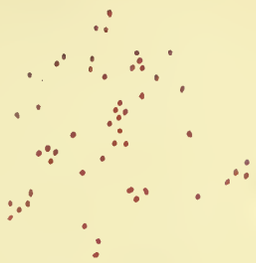


Fig. 1

X 100

Fig. 2

X 100

Fig. 3

Fig. 4

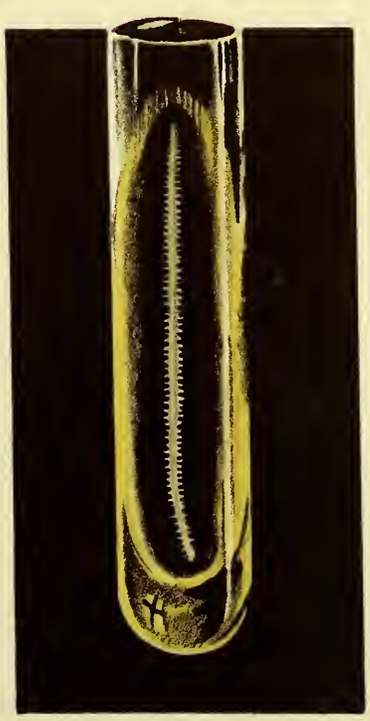


Fig. 5

Recapitulation of Characters—continued.

Bac.	Gel. Stabs.	Gel. Slopes.	Agar Slopes.	Potato.
A	Needle track, faint. Surface, pale, translucent film	Pale, bluish-white, irregular, fenestrated margin	Strong, blue-white, spreading regularly over surface	Strong, yellowish, smooth, slimy
B	Needle track, white growth Surface, faint transparent	Pale, bluish-white, semi-transparent	Luxuriant, white, growth, smooth, and shining	Yellow
C	Needle track, marked white growth Surface, strong thick white, growth, round, even edged	Strong, opaque, dead white, growth	Strong, pure, white, growth	Strong shining, cream-coloured
D	Needle track, faint, pale, growth Surface, faint, transparent	Faint, transparent, colourless	Faint, transparent, growth	Bright yellow
E	Needle track, strong, white growth Surface, milky white, raised, shining	Strong, white, opaque, smooth, margin	Strong, pure, white, serrated margin	Strong, pale-yellow, almost grey, shining
F	Needle track, faint, pale, growth Surface, faint, transparent	Bluish-white, transparent, delicate	Faint, transparent, growth	Meagre, transparent, faintly yellowish, glassy
G	Needle track, slight, white, growth Surface, faint, transparent	Faint, pale, semi-transparent, bluish-white	Marked white growth	Meagre, pale, transparent

Bac.	Milk, Coag.	Acid Formation.	Sugar, Gel. Shake, Gas Formation.	Indol, Formation.	Parietti.
					Per cent.
A	+	+	+	+	4
B	+	+	+	—	3
C	+	+	+	—	3
D	—	+	+	+	4
E	—	+	+	—	4
F	—	+	—	—	3
G	—	—	—	—	3

CONCLUSION.

From the preceding investigation it may be stated that—

1. Dysentery in South Africa is not caused by amœbæ, as there is some reason to believe is the case with the dysentery of certain other countries.

2. That the organs in dysentery are absolutely sterile. It is a local disease attacking the mucous and sub-mucous coats of the large intestine, and, unlike enteric fever, the causal agent, if any, confines itself to the intestines.

3. That in the large intestines no particular species of micro-organism stands out prominently as in the case of cholera, so that it is impossible in the present stage of the investigation to say that any special bacterium plays a prominent part in the causation of dysentery.

4. That there is not sufficient evidence in this work to bring forward the theory that some of the normal inhabitants of the intestines belonging to the coli group take on a pathogenic power.

are disposed of, and the absence of any systematic disinfection of the infected pails and utensils which are distributed indiscriminately. Owing to these two causes there is infection of the hands or food from household utensils, boots and clothes or direct contamination of the food by flies. It is not sufficiently recognised that the infection is in the urine as well as in the fæces, and that while on the one hand the infection clings to the badly-cleansed and undisinfected utensils and pails into which the excreta is deposited, and that the soil with the pail system becomes saturated in its vicinity caused by careless handling, on the other hand the infection is also spread on the soil when the urine is thrown into the backyard or on the street. Once the disease is introduced the risk of infection is greater in dirty houses with dirty householders, or in households in which the Kaffir or Indian servants are not closely supervised.

One of these small outbreaks recorded by Dr. Fuller, the Medical Officer of Health in Capetown, in his annual report for 1898, will suffice as an example of secondary infection. "A, a cart-driver, fell ill with enteric fever on February 28. He had a prolonged and severe illness, and on April 4, during the course of his illness, we find that his sister, a girl of 15 years living in the house with him and often attending to him, fell ill. We shall designate her as (A 1). On April 25, 1897, a girl friend of A 1, living in No. 3, next door, fell ill, and there is little room for doubt that she caught the disease directly from her girl friend, with whom she was doubtless often in close companionship. We shall designate her as (B). On June 4 B's brother, aged 14 years, living in the same house, fell ill and died early in July. He may be designated (B 1). Early in July, B 1's brother, aged 21, occupant of the same house, fell ill, having contracted disease undoubtedly from B. B was nursed by a married sister living in No. 7, and about the same time that B 1 fell ill she also contracted the disease and has subsequently died. It is clear then that all these cases occurred one after another at times and under circumstances that leave no room for doubt but that each caught the disease directly from the other. We find that all the seven cottages are small three-room tenements and inhabited by coloured people. In No. 3, where three cases occurred, there were, I believe, five occupants to the three rooms. As each case occurred the usual instructions were given about disinfecting the motions, &c., and yet the disease spread and was fatal in two cases. Now typhoid fever is not in the most virulent sense an infectious disease but is spread merely by means of the excreta, and yet you have here an excellent example of it fatally and easily spreading where insufficient precautions have been taken. Two things would have stopped this epidemic at its outset :—

"1. Removal to an infectious hospital.

"2. Adequate and proper nursing of the first case at the home would have prevented the further spread, but this, as I have pointed out, was a practical impossibility under the circumstances. We ought, with this class of people, to encourage cleanliness in every way, and in this particular row of cottages in which the epidemic has occurred the conditions are such as in no way to do so.

"There is no through ventilation to the majority of the cottages.

"There are no backyards, so that all the dirty duties such as washing, throwing out of slops, &c., which should be done in well-paved and drained backyards, are done in the front of each house on undrained rough soil, in many places covered with low bush in which all sorts of abominations, rags and offal, are apt to accumulate. The whole arrangements are such as tend towards slovenliness in the matter of general cleanliness."

With regard to soil pollution an interesting series of observations have been made by Dr. Stoney, the Medical Officer of Health for Kimberley. In his annual reports for 1898 and 1899 he shows that when the mean temperature for the day of the soil 1 inch below the surface falls to 60° F. enteric fever practically ceases and that when the surface earth temperature again reaches this temperature the disease reappears, and referring to the soil being the breeding place for the germs of enteric fever he remarks that the conditions which favour the growth of the germs are present in the areas around a large proportion of the houses in Kimberley: "They are polluted with organic refuse and filth which has accumulated for years and been

washed into the soil which is kept moist by constant floodings with slop water, and the heat of the sun keeps the temperature sufficiently high during the greater part of the year so that if the soil becomes contaminated with the germs of this disease, they proliferate rapidly and during our dust storms are carried into the supplies of stored drinking water, &c., in the neighbourhood, where they continue to grow and when imbibed by a susceptible individual produce enteric fever." In an analysis of some of the cases he was able to point out that in most cases when a case of enteric fever was notified it had been proved on enquiry that there had previously been a case of this disease somewhere in the immediate neighbourhood, by which the soil had probably become infected, and in many cases it was easy to understand how water used for drinking purposes stored in tanks, barrels, or worse still, water bags, had become contaminated.

There are other cases that might be quoted in which it is apparent that a soil once infected in South Africa retains its infection for a considerable period, and the handling or removing of the soil induces infection.

An insufficient protection of the water supplies and a general absence of a proper and sanitary disposal of the excreta and slop water are conditions to be met with nearly everywhere in the Colony, resulting not infrequently in an impure and unwholesome local water supply as well as in an unhealthy soil saturated with excretal filth.

Even in the larger towns such as Port Elizabeth and East London in which much has been spent in securing a potable water supply from a distance, many of the advantages derived from this are lost by a defective distribution, and the poorer quarters of the town receive a scanty supply, and the inhabitants are not infrequently dependent on a less pure source or on storage liable to contamination.

Again, in reference to drainage it is only in Cape Town that there is a network of underground drainage and that of a poor type. Other towns are mostly undrained and are provided with either a very inadequate machinery for the removal of slop water or with none at all. The system of removal of excreta is generally of a very primitive character, being only compulsory when a nuisance is created from the overflow of the bucket or tub which is used where cesspits have been abolished. The frequency of emptying the tubs or of cesspits is generally a matter of arrangement between the householder and contractor, and accordingly becomes dependent on the standard of cleanliness entertained by the householder and on the amount which the householder is prepared and can afford to pay, for no bucket is emptied under the cost of a shilling. It is under a system such as this that every effort is made by the poorer and less cleanly classes to evade payment of the tub tax which is managed by disposing surreptitiously of the excreta and urine by some other less expensive and less satisfactory manner than the calling in the services of the contractor. The result of this system, or want of system, is seen in the filthy and saturated condition of the backyards and premises of the more insanitary quarters and the condition of the lanes and more or less secluded places. Surface pollution in the poorer parts is common, and in this respect the state of cleanliness differs very little from that of English towns in the pre-sanitarian days. When infected excreta and urine is thus dealt with the infection from the soil is not only liable to be immediate, but to be retained for considerable periods. In a few towns a sanitary tax has been or is about to be introduced and the municipality undertakes to remove the tubs once a week, special precautions being taken with the tubs taken from houses infected with enteric fever.

A weekly removal system is better than a fortnightly or monthly one, but in a climate such as South Africa with its numerous flies it is offensive and extremely disgusting, the flies swarming from the latrines to the nearest unprotected food. If the tub or pail system is to be a success in South Africa, earth, sawdust, or other protective material will have to be used as a covering to the excreta and the removal will require to be daily. But for large towns the best and least expensive in the long run is underground drains for the sewage and surface drains for the stormwater, such as is being introduced in Durban.

That which obtains in the larger towns exists also in the smaller towns

and villages. There are exceptions but they only accentuate the rule. Wherever there are natives, and there are few places without them, the sluits, veldt, and retireds pots adjoining town and village are used as latrines. After heavy showers the sluits and river beds which were previously dry get filled with water polluted with excrement. At these times the water is particularly dangerous and known to be liable to cause dysentery and fever. Natives suffer both from enteric fever and dysentery. Several outbreaks of typhoid fever in localities in which typhoid had not previously existed have been traced to the pollution of the water supply by natives who have contracted typhoid in the mines of Johannesburg and Kimberley, and who in passing through the village on the way to their homes had introduced the disease.

The facilities for the pollution of water by natives and by the ordinary conditions of village life are exceptionally great because of the usual methods employed of obtaining a water supply. Over and over again it happens that the water supply is derived from a pure mountain stream or spring and is absolutely pure at its source, but by being led into the town or village in an open furrow it not only receives the drainage of the area of the land through which it passes but also the pollution of cattle and domestic animals which drink from it. Impurities, organic and inorganic, of vegetable and animal origin, are, therefore, of frequent occurrence before the water is collected for domestic purposes. Natives have on occasions been actually caught emptying the contents of the excreta pails into the furrows. Weirs built across spruits or streamlets damming up the water in order to form a reservoir at the site of the weir or to direct the water to a dam in a more convenient situation is another mode of obtaining a water supply, but which is also liable to specific pollution because of the absence of any attempt to protect the supply. The following is the description of such a supply taken from the Report of the District Surgeon for 1898 :—

" From the dams the water is conveyed by open furrows along the sides of the streets, each erf having its own private furrow joining the public furrows. The dams are not fenced in and in the dry season all the horses, cows, oxen, sheep, and goats congregate in and near them. They are also the homes of countless water animals especially frogs, crabs, &c., and yet these dams have not been cleaned out within the last 10 years. Both of them are more than half silted up with sand and mud so that they contain little water and every year the amount gets less. The open furrow along the streets act also as drains or sewers for on fall of rain all the refuse from the streets and back-yards is carried into them. The water from the dams is really intended for irrigation purposes, but most of the poor people white or black habitually use the water for all domestic purposes because it is so near at hand running past their doors. This water is without doubt clean at its source for it comes from the high mountains round the village, but all the small streams coming down the mountains and the large spruit above the weir are constantly contaminated by the various animals feeding on the commonage through which they flow. It is not unusual to find some dead animal in an advanced state of putrefaction, lying in these streams. All sick animals seem to make instinctively for water, and often in the death agony they tumble into the water. The carcase remains there until pressure is brought on the street keeper by some disgusted citizen. However, this has been effectively put a stop to by the drying up of all the streams. In ordinary times most of the washing of the clothes is done in the spruit that passes the village, but early this summer the stream ceased to flow and water could only be found in one or two holes in the bed of the stream. Still the washing went on in them till the water was almost solid from soap and filth and the smell could be felt for yards around."

The above is a type of the description of the water supply obtained from surface water given in the reports on the public health of the colony for the years 1893 to 1898 inclusive.

When the water supply is obtained from wells the fact that the mouth of the well even when covered is usually on the same level as the surface of the ground, and that all kinds of water vessels from all sorts of houses are dipped into the water, renders the liability to contamination considerable which becomes specially dangerous if enteric is introduced into the village.

The following is an illustration of this danger as reported by the district surgeon :—

"Strydenburg Village is five years old and lies on the edge of a large pan into which most of the refuse, &c., is carried by rains. The entire water supply is derived from wells, &c., the water in these wells is on the same level as the pan. The pan gets polluted from dead matter lying on veldt around village and thus helps to pollute wells which also get contaminated by sluits in village frequently being used as latrines and filth thus getting carried directly into the drinking water.

"Towards the end of September, 1897, some cases of typhoid fever came into the village from outside and were the cause of an alarming epidemic which did not abate until June, 1898, during which time well over 230 cases occurred in village and outlying farms, these latter contracting disease in village usually at Nachtmaal time. Only six houses in the village escaped free. All the inhabitants except a few refused to boil water and observe other strict injunctions enjoined to diminish risk. The epidemic was of the severest type and the death-rate amongst coloured was high owing to the absolute want of nursing and no milk whatever being procurable. Dr. Turner and Dr. M. C. Hopkins were both here to inquire into the cause of the epidemic, and both agreed with me in ascribing it entirely to water supply and want of ordinary precautions ; and at Dr. Turner's order I forwarded three Winchester quarts of water to be examined by the Government Analyst, who declared "all samples inferior, some *highly* polluted.'"

The evil effects of a combination of insanitary conditions are well exemplified in Middelburg in Cape Colony. The town is riddled with cesspools, and the inhabitants derive their drinking water from private wells on the house premises and from a supply which is brought into the town in open furrows which are practically gutters on each side of the street. This supply at its source is pure, but as horses, cattle, dogs, and cats drink from the furrows, it soon becomes impure, an impurity which is increased by exposure to the surface drainage from houses.

Dysentery and enteric fever prevail periodically, and careful investigations trace them to the water supply.

In the year 1900, out of a small population of 2,000 inhabitants, there were 221 deaths from all causes, which is equal to an annual death-rate of 110 per 1,000. There are always every year from 50 to 60 cases of typhoid fever, and in 1900 there were 7 deaths from typhoid, 39 from gastro-enteritis and 12 from dysentery.

As will be seen by the table Appendix II the rate of mortality in the chief towns of the Colony for enteric fever was in 1896 nearly eight times for Europeans and ten times for coloured people the ratio of that in England and Wales.

As regards Natal, the topography of the country is more favourable to a more abundant and purer supply of water from mountain streams than Cape Colony, yet with the exception of the Umlass River supply at Durban, the supplies for the larger centres are as a rule subject to pollution. For instance the Umbilo River supply for Durban at Pinetown is open to the risk of contamination before it is impounded, and as the only mode of purification adopted is the addition of alumnic ferric, the water is at any time liable to contain specific infections to which it may be exposed. To a far greater extent is this risk incurred at Maritzburg where the water supply is obtained from a network of surface streams, and the only precaution taken is to patrol these streams regularly to ascertain whether there are any dead carcases in or near their banks. The site of the intake to the reservoirs is particularly objectionable, having a house and a public road immediately above it. There is no attempt at reserving for the corporation considerable protective areas along these streams.

Maritzburg suffers from an excessive prevalence of enteric fever, gastro-enteritis, and dysentery, and though there are other causes at work besides the periodic contamination of the water supply, yet, as pointed out by Major Simpson, R.A.M.C., in his valuable report on the subject in 1898, it is the most obvious cause, and until the water supply is placed beyond suspicion, the other sanitary conditions can only be held to play a minor role in the causation of the diseases.

Dr. Allen, the Medical Officer of Health, traced an outbreak of enteric fever in the years 1884–85 and 1885–86 to infected milk. From this enquiry Dr. Allen believes that calves suffer from a specific enteritis, and that it is this enteritis which causes typhoid fever in Maritzburg. There was no opportunity of verifying the extent or correctness of this view, but it is worthy of further investigation. In the event of the theory being correct, it would be an additional reason for the filtration of all surface waters and for the protection of water supplies from the pollutions of cattle which is so common in South Africa.

Ladysmith derives its water supply from the Klip River; it is an improvement on the former supply, and was followed by a marked diminution in the prevalence of enteric fever among its inhabitants, but the water above the intake is not always above suspicion, and the method of filtration employed is quite behind the times, and does little to improve the quality of the water. An excellent scheme is however about to be introduced, in which the water will be filtered more in accordance with modern methods.

In all schemes of water supplies in South Africa, besides filtration on scientific methods, the principle of protecting the gathering grounds, or, in the case of a river, its higher reaches should not be forgotten. In a new country, where land can be acquired cheap, the local authorities cannot begin too early to secure for towns the ownership of the gathering grounds or the river banks above the intake. Ladysmith, Harrismith, Bloemfontein, and Kronstadt, in addition to those previously mentioned, are very much in need of these protected zones.

CHAPTER II.

Dysentery and Enteric Fever in the South African Army.

With the presence of dysentery and enteric fever in Cape Colony and Natal at certain seasons of the year, there is no necessity of seeking for some recondite cause to account for the first cases in either the Western or Eastern army. Unless the armies carried with them the most efficient means of protection, it was absolutely certain that these diseases, more especially enteric fever, would appear among the troops and would spread among them and be carried by them wherever they went.

During the two years beginning in October, 1899, and ending in September, 1901, there were approximately 24,294 cases of dysentery with 973 deaths, while during the same period there were 31,118 cases of enteric fever with 6,172 deaths, which represents for enteric fever alone nearly an army corps.

In the first year there were 11,143 admissions for dysentery with 546 deaths, and 15,655 cases of enteric fever with 3,642 deaths. In the second year there were 13,131 cases of dysentery with 427 deaths, and 15,463 cases of enteric fever with 2,530 deaths. As will be seen from the tabular statements in Appendix III, furnished by the Medical Department to the Commission, September was for enteric fever the most healthy month in both years, while May and June were the most unhealthy in 1900, and April and May in 1901. For dysentery, July, August, and September were the healthiest months.

The actual number of deaths from enteric fever amounted to more than six and a-half times that of dysentery in the first year, and slightly less than six times in the second year.

——	Period.	Admission.	Deaths.	Percentage of Deaths to Admissions.
For dysentery ..	1st year ..	11,143	546	4·9
	2nd year ..	13,131	427	3·2
For enteric fever ..	1st year ..	15,655	3,647	23·2
	2nd year ..	15,463	2,530	16·3

These tables show that the case mortality of both enteric fever and dysentery has declined in the second year, but the dysentery rate has declined in a slightly greater proportion than the enteric rate.

If, as has been stated in the first part of this report, as a probability, that some of the dysentery following enteric fever, and which often proves fatal, is merely a relapse of enteric fever, then the mortality from dysentery would be even less than is at present recorded.

The comparative absence of the fatal dysentery which usually attacks armies in the field is probably due to the excellent food arrangements in this campaign.

One great cause of fatal dysentery in armies in the field in former times was bad food. Rations of pickled pork and beef were served, which had to be cooked by the soldier himself. In many instances the meat was imperfectly salted, becoming decomposed, and had frequently to be eaten insufficiently cooked owing to scarcity of fuel. This condition of the food was always a great source of sickness. There is no more dangerous cause of bowel complaints of a severe type than meat in a state of putrefaction. The soldier in South Africa has been placed in better conditions as regards the quality of the food than in any previous war, and in proportion to the improvement in the preservation, and accordingly the quality of the food, so has one important source of bowel complaints and dysentery been practically abolished. That there has been a comparative absence of a general prevalence of fatal dysentery and scurvy may be very properly ascribed to the excellent commissariat and food arrangements of this war. By the introduction of preserved meat in tins the soldier obtains his rations perfectly fresh and already thoroughly cooked, so that the dangers incurred by eating badly-preserved rations and badly-cooked food have now been avoided.

It is a mistake, however, to send out tins containing more than a single soldier's rations for the day. In Natal there were some consignments of 7-lb. tins. When these were served out the more willing soldier had to carry this additional weight for his comrades, or the tin was opened and the meat taken out and carried in the haversack. Exposed in this way to the dust of the roads and to the sun, it not only lost its cleanliness which it preserved in the tin, but it was liable to decompose and cause dysenteric symptoms when eaten. Some of the more violent diarrhœa, with dysenteric symptoms, was attributable to this cause. There were also numerous instances of disturbances of the bowels of a dysenteric character caused by eating meat from tins which had been exposed more than a day amidst insanitary surroundings before consumption.

The most frequent cause, however, for the prevalence of dysentery was probably the drinking of surface waters, especially those of the rivers which contained a very large amount of mineral and organic matter in suspension. The water of the Orange River, the Modder, the Vaal, the Eland, and the Crocodile were at times so loaded with suspended matter as to be quite opaque, and drinking of the water was very generally followed by diarrhœa from irritation of the bowels, which in some soldiers subsequently developed into muco-enteritis.

Besides the drinking of unfiltered river water, which was also often polluted with decomposing animal matter, another cause appeared to be the sand which lodged on food during dust storms. These influences added to general disturbance of the bowels produced by irregularity in diet, exposure to wet, chill, over-fatigue, and insanitary conditions seem to have been the main contributing factors associated with the prevalence of dysenteric symptoms in South Africa. As regards enteric fever the case mortality rate during the first year as recorded in the statistics is high. This is due in a measure to many mild cases of enteric fever being placed under the nomenclature of simple continued fever. Dr. Dodgson applies Widal's test to a number of cases so classified, and found the test to react in nearly 75 per cent. If 75 per cent. of the cases of simple continued fever were added to the cases of enteric fever, it would increase the recorded prevalence of enteric fever, but decrease the case mortality rate, and would bring it nearer the ordinary mortality rate.

Dr. Coleman, physician to the Irish Hospital, applied Widal's test to cases with a temperature curve resembling intermittent fever, and ending in

the course of 10 days or even less, and found that there was usually a distinct reaction. These cases, when carefully inquired into by Dr. Coleman, were found to give a history of a previous feeling of malaise, headache, want of appetite, disturbance of the bowels, and general feverishness lasting about a fortnight. They appeared to be cases of ambulant typhoid, and this view was confirmed in a number of instances in which, after the temperature had declined and the patient was in a state of convalescence, a relapse followed showing the typical, clinical, and temperature chart of enteric fever. It is mild cases of enteric fever and cases of diarrhœa sometimes simulating dysentery, but actually enteric fever which not only add to the difficulties in the early treatment of the soldier, but also to preventive work in warfare. In the Appendix are some charts illustrative of these points.

CHAPTER III.

Dysentery and Enteric Fever at Modder River.

(See paragraph 18, Colonel Notter's Dissenting Statement.)

When, after the battles of the Modder and Maggersfontein, Lord Methuen's troops settled down at the Modder River, the camp was for the most part situated on both sides of the river near where the Modder and Riet rivers meet in their westward course. The camp of the Guards Brigade lay in the cleft or island between the rivers and communicated with the northern bank of the Modder River by means of the Guards Drift above which was a reservoir which formed the principal source of the water supply. Below the junction of the rivers is Rostalls Klip Drift, the chief place used for watering the horses, and still further west is the railway bridge crossing from south to north, and beyond this below the bridge is the pumping station on the south side of the river to supply Modder River water to the railway station on the north bank. The soil is chiefly limestone, and the drainage is towards the river banks which are cut into by large and numerous sluits formed by flood waters and which are covered by small trees and bushes.

Cases of dysentery were admitted to hospital from the commencement, but it was not until the week ending December 22 that a case of enteric fever was noted as being admitted into the Orange River Hospital which had been transferred from Modder River and which was followed next week by three other cases of enteric fever from the same source. For the week ending December 29, 15 cases of enteric fever were admitted into the Modder River Hospital. In connection with some of these early cases Colonel McGill, who was in charge of the Guards Brigades, noted that of the first two cases under his charge occurred on December 26, and two on the following two days. All four cases came from the same tent which was pitched on the bank of the Riet River, the water of which was in an unsatisfactory condition. The fact that the four were attacked at the same time indicated a cause in common.

Admissions into the Modder River Hospitals.

Period.	Number of Dysentery.	Number of Enteric.	Number of Simple Continued Fever.
Week ending—			
December 1	30	—	5
„ 8	32	—	9
„ 15	34	—	—
„ 22	13	—	9
„ 29	15	15	4
January 5	11	5	7
„ 12	5	14	25
„ 19	4	6	34
„ 26	7	12	41
February 2	9	41	38
„ 9	29	47	92
„ 16	32	19	137
„ 23	27	54	98

An explanation of the rapid rise in simple continued fever is to be found in a note in the hospital returns of De Aar Camp that numbers of the cases admitted as simple continued fever had to be changed to enteric fever.

It is evident from the above figures that both dysentery and enteric fever were prevalent in the Modder River army before any portion of it started for the relief of Kimberley or in pursuit of Cronje, and that the portion of Lord Roberts' army, concentrating at Modder River, incurred considerable risk of becoming infected.

The Boer army which opposed Lord Methuen in his advance northward was not free from enteric fever. The Orange Free States army completed its mobilisation at Olifantsfontein on October 15 and then split up into different commandoes. The Bloemfontein commando went south and encamped near the Modder River, south-east of Kimberley, other commandoes went westwards and encamped south of Kimberley, the investment stretching across the railway line. Some 2,500 men were left at Olifantsfontein. These commandoes were drawn from parts of the country where enteric fever was beginning its seasonal prevalence, while in the vicinity of Kimberley itself there are annual outbreaks of enteric fever. From Dr. Ramsbottom, the Principal Medical Officer of the Orange Free States Army, we learn that the first case of enteric fever which came to his notice was sent into Olifantsfontein from one of the laagers south of Kimberley. The patient was an artillerist from Bloemfontein, who had evidently contracted the disease before joining the commando; this case was sent in towards the end of October. Reports of other sporadic cases, occurring in the different camps soon after the battle of Belmont, came to Dr. Ramsbottom's notice, but he was of opinion that the few early cases were imported. There can be no doubt that enteric fever was amongst the Free Staters before the arrival of the Transvaalers. In the Transvaal force there appears to have been no recognised enteric cases before the battle of Maggersfontein. By December 14, however, four suspicions cases were in the Jacobsdal Hospital, and by December 22 there were five well-marked cases; by the end of January there were more than 100 cases. According to Mr. Draper, the Casualty Officer of the Transvaal, who made an investigation into the epidemic, this outbreak was mostly confined to the commandoes which took their water from a highly polluted well at Maggersfontein and situated a long distance from the Modder. All the sick were sent to the hospital at Jacobsdal and the drainage of Jacobsdal passes into the Riet River.

As regards sanitary arrangements in the Boer camps, whether Transvaal or Orange Free State, there appears to have been none. Special places were pointed out to the Boers for defecation but they could never be induced to use them. In killing cattle for food, the offal was not buried but thrown on to the ground or into the trench to dry by the action of the sun; excreta and refuse were left unremoved. The consequence was that their camps were in an exremely filthy condition, and the stench was unbearable for a considerable distance from the camp. This condition of things occurred at every place where a Boer camp was established, and was specially bad at the Modder River, at Ladysmith, and at Colesberg where the encampments were established for a long time. Dr. Ramsbottom believes that the saving circumstance which protected them in a degree from the effects of these insanitary conditions appears to have been their universal practice of not drinking unboiled water. While in camp the Boer generally drank coffee, and it was only on patrol duty that he drank water in its natural state. He invariably attributed, and probably not without good reason, any illness he contracted to the water in his water-bottle. The consequence of the filthy condition of the camps just described, one of which was immediately above the principal source of the water supply to Lord Methuen's camp, and in consequence of the drainage of the town of Jacobsdal flowing into the Riet River which also supplied water to a portion of the British camp, the danger to the health of the British troops was not likely to be small. The first thunderstorm would send every kind of filth, infective and non-infective, swirling into the Modder and Riet rivers, the inrush to the rivers being favoured by the fact that the trend of the drainage for the districts on both sides is towards them.

The British camp itself was, however, far from being in a good sanitary

condition. The site topographically was not favourable to cleanliness. The soil was of limestone formation with sandstone underlying and rendered the digging of trenches a matter of labour and difficulty. Shallow trenches in many instances took the place of deep ones with the result that during the floods they drained into the river, and during dust storms paper, &c., was lifted from these trenches and scattered about the camp. The sluits by the river and the bushes afforded opportunities for defilement of the ground without detection ; dead horses and cattle were buried too near the river and never deep in the ground, and a number of the bodies of soldiers killed in action were buried practically on the slopes of the river bank. These bodies appear to have been buried in such shallow graves that after heavy rain they became partly exposed. With such conditions in Boer and British camps and with wet weather the fouling of the water of the rivers became a certainty. The least contaminated water from the river was apparently the supply derived from Scholtz dam above the Guards drift. The Boer camp for six weeks before the battle of the Modder was about 1½ miles above the dam and after the battle several miles above. The most polluted was that taken at or below Rostalls Klip drift, even the horses seemed to have suffered. Below the Klip drift and the bridge, the water from the river was pumped up to the station tanks, but the troops used so much from the tanks that the Commanding Royal Engineer stopped water being taken direct from the tanks because it was required for the railway engines. There were, however, five taps connected by pipes from the tanks to the railway officials' houses and to the station, and the soldiers were able to draw off water from the tanks by means of these taps. It is interesting to note here that most of the railway telegraph and post office employés residing at the station using the water from the taps were attacked with enteric fever.

It is important to mention that previous to the war the water pumped up from the river to the railway station had always been filtered before it reached the tanks, but at the battle of Modder River a shell had destroyed the filters as well as the pump, and the military had to erect a temporary pump but without the filters.

On January 17, 1900, Surgeon-General Wilson, the Principal Medical Officer, visited Modder River camp and found it in an unsanitary state. He recommended to Lord Roberts in Cape Town that wells should be sunk for the troops not only at Modder River but on the lines of communication between Orange River and Modder River. Lord Roberts immediately agreed and the ordinary machinery under the Royal Engineers was put in motion for this purpose. So slow, however, was this machinery, which is not specially adapted for this work, that it was not until February 9 the requisite number of wells was completed. A portion of the troops began to leave the Modder River on February 11.

It was in anticipation of Lord Roberts' advance to the Modder that the question arose whether a large supply of water might not be obtained for the troops and for the convoys by bore-wells sunk at the different camps. Bore-wells had already been sunk with success by the Cape Government for General Gatacre at Sterkestroom.

The officer commanding the Royal Engineers on lines of communications approached the Cape Government on the subject, and on January 29 the assistant inspector of boring received a telegram from the Public Works Department of the Cape Government to proceed to Orange River to report himself to Major-General Wood, R.E., Engineer-in-Chief, with a view to deciding whether the water supply of the camps could be increased by boring. On the inspector's arrival at Orange River on January 30 Major Bethel, R.E., Staff Officer to Major-General Wood, took him to Enslin where they arrived on January 31, and after he had made a thorough geological survey of the camp at Enslin he reported that water could be found by boring. After proceeding back to Rosmead and Cradock to arrange about the supply of plant and men, and after their arrival at Enslin the work was commenced on February 5 and completed in 34 hours on February 7, when nearly 600 gallons per hour of perfectly fresh water was obtained. Three out of four wells sunk at Enslin were a success, three out of four failed at Graspan owing to dolorite being found near the surface, while one at Honey Nest Kloof station gave 6,000 gallons per 24 hours. The details connected with the borings are to be found in Appendix VIII.

However useful the wells at the Modder River and on the lines of communication were for a portion of Lord Roberts' troops, yet, as the Modder River wells were not completed until February 9, and the greater portion of the Modder River troops left the Modder River camp a few days afterwards, the advantages derived from these wells were small and their influence in checking the rising epidemic at the Modder was almost nil.

As preventive works they should have been constructed, not when an epidemic was manifesting itself, but immediately the camp was formed which would have been nearly two and a-half months earlier. The medical officers adopted preventive measures as far as they were able in order that the soldiers should be provided with good water, but there was no general organised scheme by which abundance of pure water was obtainable. Plenty of fuel was available for, although the Modder River district is barren of trees, there was the railway behind to bring up coal.

CHAPTER IV.

Dysentery and Enteric at Paardeberg and Bloemfontein.

(See paragraph 18, Colonel Notter's Dissenting Statement.)

Both the Boer and British Forces were infected when they left the Modder River and started for Paardeberg. On the British side a number of sick from enteric fever and simple continued fever, which turned out to be enteric, were sent back from Paardeberg at a time when it was too early for them to have contracted the disease at the latter place. They formed a part of the epidemic at the Modder River. On Cronje's surrender on February 27, there were 10 cases of well-marked enteric in his camp, two of whom were dying. They, too, were for the most part remnants of infection contracted at the camp at the Modder or Maggersfontein. The investment at Paardeberg was not sufficiently long for them to have contracted their fever in the laager at Paardeberg and to be in the condition in which they were found. The period of incubation of enteric is seldom less than a week, and more usually 10 days to a fortnight, or even longer. A week to a fortnight may be taken as the general average, though on occasions it has been nearer three weeks. But though these 10 cases did not contract the disease in the Paardeberg laager, yet the large number of Boer prisoners who afterwards fell ill of enteric at Cape Town and on their way to Cape Town undoubtedly contracted their sickness during the Paardeberg investment, just as numbers of the British Force fell ill later on their march to Bloemfontein of enteric and dysentery contracted at Paardeberg and were sent to hospitals at Kimberley and the Orange River. 127 cases of enteric and 56 cases of simple continued fever, and 75 cases of dysentery were admitted into Kimberley Hospital between March 9 and March 23 from the army marching on Bloemfontein. The conditions at Paardeberg were exceptional, many of the troops being particularly exposed to the danger of contracting disease, owing to the pollution of the river which formed their main source of supply of drinking water.

From the evidence of those present it is to be gathered that the conditions were exceptionally unhealthy, owing to a large number of the troops having to drink water contaminated with excreta and dead animals, and there being no appliances for purification. The geological formation of this district is sandstone and shale with ironstone, so that if there had been a health department with the requisite machinery and staff, there would have not been any difficulty in procuring an abundance of naturally filtered water by boring.

The troops arrived at Bloemfontein on March 13. By March 30, *i.e.*, 17 days after their arrival, 250 cases of enteric, 759 cases of simple continued fever, and 56 cases of dysentery had been admitted into the Bloemfontein hospitals. These numbers do not include the sick of the Colonials. It is clear from these figures that the Army of 33,000 entering Bloemfontein was an infected one. But March 30 was exactly six weeks after the operations at Paardeberg began, 38 days after the investment of Paardeberg was completed, and 30 days after the troops left Paardeberg.

If due allowance be made for the dislike of the soldier to report himself sick when on active service, and to the fact that numbers are stated to have come into hospital in the second week of their illness, this period more than amply covers any infection contracted at Paardeberg. The figures in the last week more probably include a large number of cases contracted on the march between Paardeberg and Bloemfontein. Certainly by April 6 all the Paardeberg cases were eliminated and in hospital, as well as the majority of those who might have contracted the disease on the march from there. After April 6 the typhoid fever in Bloemfontein and its vicinity was probably contracted locally. It may, therefore, be considered separately. The advancing Army left Bloemfontein on May 3. Many of its sick were sent back during the first three weeks, which period may be taken as the limit of time to cover cases of enteric contracted at Bloemfontein before departure from that town. Most of these cases on arrival at Bloemfontein Hospital were entered in the books as transfer and not as admissions into hospital, so that the number of admissions during this short period scarcely represent the total number of cases which contracted their disease in Bloemfontein and its vicinity. These admissions appear in the Field Hospital admission and discharge books otherwise one man would count as two admissions. With this proviso there were between April 6 and May 25 at least 4,806 admissions into hospital. These numbers do not include Colonial troops.

Of the 4,806 admissions 2,530 were enteric, 1,750 simple continued fever, and 526 dysentery.

These figures make a total of 4,280 cases of enteric fever and simple continued fever, which, estimating the Force at 40,000, gives an incidence rate on the Bloemfontein Army of 10·6 per cent. in the course of seven weeks, or if 75 per cent. only of the simple continued fever cases be viewed as enteric, then the incidence rate was 9·6 per cent., *i.e.*, nearly 10 per cent. of the Force was disabled and could no longer continue military operations. If only the figures which are recorded as enteric fever during the seven weeks be taken, and the Army as 40,000 men, then over 6 per cent. of the Force was attacked. The actual strength of the troops that marched into Bloemfontein on March 13, 1900, was 33,954. This extremely severe outbreak belongs to Bloemfontein and its vicinity. If the sickness from simple continued fever and dysentery, which took place on the march to Bloemfontein be added, it amounts to over 6,000, *i.e.*, at least one-eighth of the Army which took this route, and which primarily became infected in Lord Methuen's camp, was placed *hors de combat* from these diseases alone.

During the 18 weeks from March 13 to July 13, excluding the admissions for dysentery and simple continued fever, there were 4,420 admissions for enteric fever into the Bloemfontein hospitals.

It is unfortunate that there are no statistics which will permit of a precise and exact analysis of this outbreak either as attributable to the march or to Bloemfontein and its neighbourhood. In the absence of statistics to show the incidence on the different units which encamped at Bloemfontein or its neighbourhood, it is impossible to point out the camps which were affected most heavily and those which were affected lightly, but that there was a very considerable difference is certain from general information gathered. The form on which the weekly returns are compiled is in Appendix IV. It gives the number admitted into hospital, the cause of sickness, the number admitted sick from the different regiments, but not the cause of sickness, and the names of officers and men who have died, and the cause of death. There is space for a general statement as to the health of the troops and the sanitary condition of the camp, but this statement seldom conveys more information than that the health of the troops or the sanitation of the camps is satisfactory or the reverse. There is no definite information as to the nature, number and distribution of zymotic sickness occurring in the camps. The statistical returns used in this campaign, when collected at headquarters, represent summaries of the number of sick and wounded and the nature of the sickness prevailing in the whole South African Army at a given time, and summaries of the hospitals in which the sick and wounded are distributed. From the point of view of a medical summary and for general registration purposes they are excellent.

The records in the hospitals from which the above returns are compiled

are the admission and discharge books which furnish certain important particulars regarding the patient and the regiment to which he belongs. The heading is given in Appendix VI. At the termination of the war the data in the admission and discharge books, when collected and carefully collaborated, will be exceedingly useful as a basis for the medical history of the campaign. The information, when available, will bear on the curative treatment of the sick and the wounded, and will prove in this respect to be of the utmost value. But while both records are extremely valuable from a medical point of view, they are valueless from a sanitary aspect. They are of no assistance in elucidating the causes producing the enteric fever, simple continued fever and dysentery in the Army, and they are useless for preventive work, which requires that the records give the necessary information at once. In order to check disease it is absolutely essential to be cognisant of the sickness in each camp as it occurs. A record of the number of sick in hospital and the nature of that sickness is essential for administrative purposes in connection with the arrangement of the hospitals and the number of beds probably required, but it is not a record of the distribution of the sick in hospitals that is wanted for sanitary purposes, but a record of their distribution in camps.

Neither the weekly returns nor the admission and discharge books contain any definite information on this question. This is probably of small importance in times of peace when the hospital receives the whole of the sick from one camp, when the camp is small, is situated in one place, and every case of zymotic disease is carefully inquired into and forms the subject of a special report, but in war time when hospitals receive sick from different regiments, when regiments are more or less broken up performing duties at different camps, and when large numbers of troops are collected together in many different camps in and around a town, an accurate record of the zymotic sickness in each camp becomes a matter of vital importance. There is no other method of focussing or locating any special disease occurring in a large force and of at once obtaining the requisite information in order to deal promptly with the causes and the disease. (See paragraph 2, Colonel Notter's Dissenting Statement.)

The importance of the statistics being arranged according to camps is readily understood when it is stated in Bloemfontein and its surroundings there were many camps and many different sources of water supply. The Bloemfontein returns not only failed to give the distribution of dysentery, enteric and simple continued fever in the different camps and units, but they failed to indicate how much belonged to Bloemfontein and how much to localities some distance away, the sick from which were sent into the Bloemfontein hospitals.

Information regarding the general health of an army encamped in a town and its suburbs is too indefinite in character to be useful as a criterion for sanitary purposes, and it is requisite to procure data regarding the health of the regimental units of each camp.

The percentage of sickness may be small when taken on the numbers of the whole Army, but may be enormous when considered in relation to the particular body of men affected. There could easily be a commencing epidemic in several of the camps and yet no indication of this shown in the statistics or in the percentages on the troops as a whole; 30 cases of dysentery, enteric, or simple continued fever in one week in a force of 35,000 is not likely to attract attention or likely to give a warning as to an impending epidemic, but if these numbers are focussed down to one or two camps the information is definite, it signalises the necessity of immediate investigation and the introduction of prompt measures to check the disease and prevent its spread to other camps. Each camp and post is a village or small township usually sanitarily separate as regards its water supply, latrine arrangement, disposal of carcases, and all other arrangements which require to be provided when a large number of men and animals are brought together, and as such must be separately dealt with statistically.

In order that these observations may not be misunderstood it may be stated that the absence of a special sanitary service as will be explained later on, is in no way due to any mal-administration on the part of the present medical staff of the army whose splendid work and devotion to duty under circumstances of exceptional difficulty and stress cannot be sufficiently

appraised, but it is due to a system which, while maintaining a very complete and well thought-out organisation for the transport and the treatment of the sick and wounded, does not include a special sanitary organisation for the prevention of disease.

In the only regiment about which definite information was obtained the recorded admissions of suspected enteric while at Bloemfontein, excluding those which occurred before April 6, amounted to over 19 per cent. of the strength. Though remarkably heavy 19 per cent. does not represent the whole because it does not include admissions to hospital during three weeks when the records were destroyed by a rainstorm and the regiment was without tents. The regiment did not leave Bloemfontein until June 6. From March 14 to June 16 the regiment had 152 cases of enteric, equal to over 21 per cent. of its total numbers, of one man affected in less than every five. For the reason stated there were no records between March 27 and April 28 which would have increased the percentage to a still higher rate. The regiment like some others was encamped not far from a highly polluted dam which received the surface drainage from the surrounding high land and from which many of the men drank. Later it received its water supply from a well in town which has been noted for years in Bloemfontein as causing typhoid, viz., the Bamann Square Well.

Bamann Square has been an enteric locality for years and it is sufficient to see the well which supplies most of the inhabitants of the neighbourhood to know the reason. The well is in the middle of the square and though possessing a cover is in no way protected from surface pollution. The square itself is used as an outspanning station, and is as a rule, especially on market days, filled with men, cattle, and carts. The regiment afterwards received its supply from the fountain.

The impossibility of obtaining the necessary material or information to make an analysis of the incidence of dysentery, enteric fever, simple continued fever and diarrhœa on the different regiments, and on the camps that were occupied in and around Bloemfontein indicates at once the absence of the essential machinery required at a sanitary bureau. With the intelligence on this subject defective there were neither the data for immediately locating the particular causes at work on the particular bodies of men nor the means of foreseeing and forestalling, checking, or controlling the epidemic with any degree of precision.

It will perhaps be possible after the war is over to ascertain by much clerical labour the incidence of dysentery. enteric fever, and simple continued fever on the different regiments and units but not as regards the camps in which the disease was contracted. At that late stage the information will be valueless from a preventive point of view or from any other. For preventive work the records require to give the information at once, precise and early intelligence as to the position and movements of an infectious disease being as necessary to combating it as intelligence of the position and movements of an opposing army is to the generals concerned.

The Army was not only an infected one but it brought a large infection to a most favourable soil when it entered Bloemfontein and occupied the surrounding country. For some years past enteric fever has prevailed annually in Bloemfontein, and several outbreaks have occurred on the farms around. The Commission was much assisted in its enquiry into the previous health conditions of Bloemfontein and the surrounding country by Drs. Savage, Dalgleish, Stollrecter and other medical men who have practised there for many years. From these gentlemen we gathered that there is a distinct history of typhoid fever having been introduced into Bloemfontein from Kimberley. Before this occurrence, notwithstanding the existence of wells and cesspools and pollution of the soil, typhoid was not one of the diseases from which the inhabitants suffered. It is on account of this freedom from typhoid at a very insanitary period that the authorities have found it difficult to persuade the older inhabitants that the later prevalence of the disease is due to insanitary conditions. Since the introduction of the specific germ, however, the disease has gradually become endemic, appearing sporadically at first but within the last few years assuming larger and larger epidemic proportions. It prevails generally from the middle of December in a slight form, lulls down for a short period, and then begins again about the middle of January and goes on to the

middle of May, and then gradually disappears. At the time when typhoid prevails other allied diseases such as colitis and colongitis are prevalent. All degrees of colitis are common, the most usual symptoms being pain in the ascending and descending colon, the passage of blood and mucus alternating with diarrhœa and fully formed motions, irregular fever, debility and loss of appetite. These symptoms may go on for a fortnight or several weeks. Dr. Dalgleish believes them to be allied to typhoid.

It is noticed that typhoid fever begins some short time after the rains. There are slight rains towards the end of September and heavy rains in January. It is unanimously held that the main cause of the typhoid fever is the pollution of the wells after the rains from a polluted soil and from the cesspits. The native population suffer as well as the white, and as the natives are exceedingly careless and dirty in their habits the soil in proximity to the wells becomes extensively polluted. The Kaffir girl or boy throws the slops and even typhoid stools and urine anywhere on the ground. Well established and specific instances were given by the medical men of small outbreaks of typhoid fever coming under their own observations being produced in houses by polluted wells.

An instance was also given by Dr. Dalgleish of an old infected cesspit being opened and causing typhoid to those who assisted cleaning it out. It was in a school where a number of boys assisted in wheeling the barrows of soil from the cesspit. Within a fortnight all the boys who had been engaged in the operation were ill with typhoid fever while none of the boys absent from the operation were affected.

In 1897 there prevailed in Bloemfontein the severest epidemic of typhoid which the civil population has suffered from. In that epidemic it is estimated that there were about 350 persons attacked out of a white population of 5,000, which is 7 per cent. of the population. There was one quarter of the town occupied by some 700 people belonging to the railway. These people had no cesspits to overflow into the wells but had a pail conservancy system distinct from that used in the town. The water supply was also distinct for they were supplied from a deep well and from rain water tanks some of which were above and some underground. During the severe epidemic only six cases of typhoid fever occurred in the community, and Dr. Savage, the Medical Officer, after investigation found that each of these cases was imported and had not contracted the disease in this special locality. This remarkable immunity of the railway employés in their own quarters though they numbered nearly one-seventh of the total population of the town disposes of what is a popular and favourite notion, viz., that the enteric fever is generally caused by dust storms. As a matter of fact, the prevalence of enteric fever does not synchronise in any way with the dust storms, which appear to be more connected with the causation of diseases of the respiratory passages than with that of the intestinal tract. It may be observed here that the most careful and thorough investigations into the prevalence of enteric fever in the Cape Colony by the Health Department during the last six years have resulted in usually tracing the causation to specifically polluted water, and in no instance to dust storms. Until May, 1899, Bloemfontein depended on wells, public and private, 60 to 120 feet deep and sunk through sandstone, shale, and gravel. Some of these wells were fairly protected from surface pollution and gave as a rule good water, while others on the other hand, owing to the absence of coping and proper staining were subject to surface pollution, and owing to the existence of cesspits to contamination from filth percolating through the soil. There is no system of sewerage in Bloemfontein, and it is only within recent years that a pail system of conservancy has been introduced. There can be no doubt, however, that the sanitary condition of the town has been gradually improving, and much was expected in the diminution of typhoid fever from the introduction of a filtered public water supply which was brought into the town in May, 1899. Its full distribution was not completed when the war broke out, nor were all the wells public or private closed. At the time of the visit of the Commission there was no compulsion to take the water, the poor people supplied themselves with well water. The waterworks are situated 21 miles east of Bloemfontein—on the Bloemfontein–Ladybrand Road. The water is stored in the Modder River by a weir 6 feet high which throws back the

water some 14,000 feet. It is taken from the river through a tunnel 200 feet long into a well 34 feet deep in the engine-house and pumped from there by three throw bucket pumps into two settling tanks containing 1,100,000 gallons each. The water from these is drawn off alternately and passed on to three sand filters, each 50 feet square. The sand, however, is not of a character to ensure proper filtration, and while it fulfils the conditions of mechanically removing suspended matters it may fail in some degree in its vital action the most important conditions connected with sand filters. From the filters the water is brought into a regulating chamber fitted with valves which regulate the head on the filters and prevent the water coming through the sand at too great a velocity. After passing through this chamber the water is stored in a covered clear water tank which supplies the main pump that forces the water to Bushman Kop whence it flows by gravitation to the reservoir in Bloemfontein. This reservoir is also covered, and has a capacity of 800,000 gallons. On its way to Bloemfontein the water is pumped up some 500 feet to the summit of Bushman Kop and from there reaches the Bloemfontein Reservoir by gravitation. All the machinery is in duplicate, and the storage in the river by the weir allows in the dry season of a storage of 88 days. The Commission visited the waterworks and were well satisfied with the arrangements provided. The riparian rights for many miles up the river should be acquired by the municipality or Government, and no houses or farms be permitted nearer the river than 1 mile on each side for that distance. It is only by a restriction of this kind with very careful attention to filtration and proper material being used that under the exceptional circumstances of South Africa, with its rivers at one time waterless, or almost so, and at another time in full flood from the surface drainage of the surrounding country water can be safely taken from rivers as public supplies. This riparian preserve would require to be strictly guarded to prevent pollution by Kaffirs and others or by animals. In May, 1900, the water supply was found on examination to contain nitrites, and an examination of the river a short distance above the reservoir disclosed a number of dead animals in the water. These were stray transport animals which had got into the water and died there at the time when the Boers were in possession of the waterworks. (See paragraph 3, Colonel Notter's Dissenting Statement.)

Typhoid fever has been spreading for the last few years on the farms in the vicinity of and at some distance from Bloemfontein, the disease has, moreover, been spreading from the capital to the villages, even as far as Winburg. The extension of typhoid fever is attributed to the Boer farmers, or villager or Kaffir coming into town and taking home the infection. Very little precaution is taken by the Boer farmer, but none is taken by the Kaffir, and as both move about until they are absolutely compelled to lie down on account of their illness they carry infection wherever they go, and the disease has every opportunity of becoming endemic and spreading in the locality into which it is introduced. In the future sanitation of the country it must be remembered that the Kaffir is a very important agent in the maintenance and spread of enteric fever, and that protective measures for the white man will be altogether inadequate unless also applied to the Kaffir. The general arrangement at present is to let the Kaffir live in any condition of filth, it being forgotten that he is intimately associated in the every day life with the white man, whether soldier or civilian.

Some two years ago an incident took place at a Christmas dance at one of the farms some distance from Bloemfontein, which shows how enteric can be spread at a considerable distance from an infected well. There was a large gathering of relatives from neighbouring and distant farms. Within a fortnight of the dance nearly 70 per cent. of those who attended the dance were laid up with typhoid fever. It appears that a barrel of ginger beer had been obtained from Bloemfontein, which had been drunk very freely of, especially by the younger women and children. This ginger beer appears to have been prepared with water from a contaminated well in Bloemfontein.

Within the past two years all the farms on the Dewetsdorp road have had typhoid fever, among these may be mentioned Paardenil, Kareefontein, Leeuwkop, Werste Geluk, Kalkbult, Paardekraal, where British troops encamped or passed in large numbers. At Leeuwkop a fight took place. The Glen, Tempe, Nooitgedacht, Rustfontein, Reddersberg, Edenberg, and

Springfield have all had typhoid fever on them. In fact it is difficult to find a farm which has escaped having typhoid fever upon it during recent years.

Such then were the conditions of the town and country into which an army already infected with enteric fever entered. There was one circumstance, however, which was all in favour of the army when it entered Bloemfontein, viz., that nine months before an excellent and abundant water supply had been brought into the town and distributed in pipes. Mr. Peet, the Municipal Engineer, did excellent service for the British army by erecting special standposts from which the regimental carts in the different divisions could draw pure water, and by assisting in having pipes laid from the town supply to the 6th, 7th, and 9th Divisions. Unfortunately this supply was cut off by the Boers, so that from April 3 to May 10 the troops as a whole, although ordered only to take from "the fountain well," obtained their supply of water largely from the old wells and springs of Bloemfontein, the majority of which were known to be subject to pollution, and for which reason £105,000 had been spent by the town in bringing in a pure supply. The troops outside the town got their supply from the farms.

There was one well in town called the fountain which derives its water from superficial land springs, the water of which has always been reputed to be particularly pure. Doubtless this reputation for purity was deserved. Under ordinary conditions the gathering ground of this well or spring is the uninhabited high lands and open veldt on the west of the town. The occupation of the gathering ground by masses of troops, some of which are infected, and by a field hospital in which enteric cases were treated, altered vastly the clean conditions which had hitherto prevailed.

When the water supply was cut off, this spring or well was one of the favourite supplies for a certain portion of the troops, and such was the drain on it that the level of its reservoir was reduced to so great an extent that the supply which it furnished to the lower portion of the town nearly ceased. About April 12 rain fell, which considerably augmented the supply. The water then showed discolouration, which was due to surface pollution. It was not until after April 12 that the excreta from the hospital was otherwise disposed of than by burial. The conditions were accordingly very favourable for the dissemination of the disease, viz., a well supplied by a superficial land spring, the occupation of the gathering ground of that well or spring by infected troops, and the burial of infected excreta on a portion of the gathering ground, excessive pumping on the well reducing its level, ending in a diminished supply, heavy rain on the polluted gathering ground increasing the supply to the well, and that supply perceptibly affected in its colour. The condition of some of the other wells which had to be used were obviously open to pollution, and were known to be the cause of enteric fever in the neighbouring houses. A number of the wells probably supplied water which was not polluted, and those who depended on rain-water tanks for their drinking supply were not affected.

There were other causes at work besides polluted water, but there can be little doubt that if this cause had not been in operation a very large number of the enteric fever cases at Bloemfontein would never have occurred. The drinking of infected aërated water and milk bought from Kaffirs probably contributed to the prevalence of the disease, but these really come under the category of infected waters. Even as late as September the Commission, on visiting one of the chief aërated water factories in Bloemfontein, in charge of a European, found that the water used was that from a well. It was stated to be filtered through a Berkefeld filter, but on opening the latter it was discovered that one of the bougies was broken lying in the bottom of the filter, and that as a matter of fact the water was not filtered. The premises were filthy, and an immense overflowing cesspool was in the immediate vicinity of the well. The use of the well water was at once stopped.

In addition to specifically polluted water, the insanitary condition of some of the camps was also a contributing factor, especially improperly dug and badly kept latrines, but except the 7th Division, that part of the army in the immediate vicinity of Bloemfontein was provided with a pail system of latrines. A sanitary removal system was started at a very early date after the arrival of the army by the Municipal Engineer. This service included the

6th and 9th Divisions and the Field Hospitals. 3,000 pails were provided, made out of oil-drums obtained from the Railway Department. The service for the hospitals inside the town were organised as the hospitals were established. On an average 100 night boys were employed extra for the Military Sanitary Service. A service for the burial of dead animals was organised by him. The number of men employed burying animals varied from 9 to 40, and the average number of animals buried daily was 20. After representations every assistance was received from the military authorities.

In connection with latrines, flies have also probably played an important part. They swarm on badly kept latrines, and pass from the latrines to the kitchen or on to the food, and thus convey infection from infected latrines to food and drink. The infected latrines are, however, likely to play a more direct part. Contamination of boots, clothes, utensils, and hands at the latrines, or from ground near the latrine polluted with infected urine, probably assisted in a fair proportion of cases in spreading the disease, more especially in the later stages of the epidemic when the ground was fouled. Dust was blamed, and possibly under exceptional circumstances of a very filthy camp it may be a factor, but our observations did not lead us to form the opinion that it played an important rôle.

Allowing, however, for the full force of each of these factors and they all come under sanitation of the camp the one conspicuous fact which has to be borne in mind is that if polluted water had not been in operation in Bloemfontein and elsewhere the greater part of the enteric fever would probably never have occurred.

Dependent as the army was on the quantity and quality of the water it obtained wherever it encamped, for with the exception of the hospitals it was practically without any organised and well established system to control the collection, storage, filtration or other means of purification and distribution of water to the troops, there was no reason to suppose that nature under the circumstances mentioned would act differently towards this army than science and experience have during the past 50 years taught us to be the invariable rule. The law is that if infected water is drunk a certain percentage of those who drink this water, especially between the ages of 20 and 30 will be attacked with illness and a certain percentage of these will die. An army must necessarily be dependent on the quantity of water which it obtains on the march or wherever it encamps, but no army unless in a beleaguered town should or need be dependent on the quality of that water. The quality of the water drunk should be as completely under the control of the army and should be as much an object of solicitude as the quantity and quality of the provisions. There is a special staff to provide for the latter and it is of equal importance that a water section should be attached to each unit. It is of vital importance to the army that there should be arrangements to secure and provide a pure water supply under every circumstance, no matter what the quality of the water is when it is brought to the water carts or to the camps.

It was well known that to drink the water of the Orange River or the Modder River in its natural state was subsequently to suffer from diarrhœa often of a dysenteric character called "Modders," a disease which predisposed the men to more serious illness. The tendency is to treat this occurrence as one of the incidents of warfare which military exigencies brought about instead as an incident which could and ought to have been prevented. The blame, however, lies neither with the military officers nor with the military departments, but rather with the system as a whole whose organisation has not provided either the staff or the machinery to carry out these precautions.

The main facts connected with the Bloemfontein outbreak of dysentery and enteric fever may be briefly summarised as follows :—

(1) An army previously subjected to much privation and fatigue and a portion of which is infected with dysentery and enteric fever arrives at Bloemfontein on March 13 and encamps in and around the town.

(2) Bloemfontein is in possession of a recently-introduced filtered water supply brought in at great expense ; the reason for the new supply being the annually-recurring outbreaks of enteric fever and dysenteric diarrhœa which were chiefly attributable to the well water polluted by infected cesspools and surface filth.

(3) Several farms in the neighbourhood of Bloemfontein at and near

which some of the troops encamp have in recent years been centres of enteric fever.

(4) A sudden dislocation of the arrangements for the water supply of the bulk of the army occurs owing to the water supply for the town being cut off by the enemy and the army has to fall back on the former insufficient and condemned supply of the town rendered more dangerous by the surface pollutions which ensue from the infected encampment of a large army.

(5) No general or special purification of the water which the troops have to drink is effected and no scientific method of checking the disease is possible because the army is totally unprovided with any special sanitary corps solely concerned with the health of the troops and the prevention of the spread of disease and provided with the necessary machinery and staff to focus, localise and ascertain the causes at work in particular camps and to meet such military exigencies.

(6) Between April 6 and May 25, a period of seven weeks, 526 cases of dysentery and 4,280 cases of enteric fever and simple continued fever were admitted into the Bloemfontein hospitals, representing 10·6 per cent. of the Bloemfontein army with the result that the hospital accommodation and medical and nursing arrangements which were strained to meet the large number of sick before that period were overwhelmed by the enormous influx.

As at Modder River so at Bloemfontein when the situation became serious an attempt was made to obtain pure water and as the trained men and special machinery required were not in the army the water borers of the Cape Government who had done such good service at Enslin, Graspan, and Honey Nest Kloof and who were now at Springfontein were sent for and were again brought into requisition in Bloemfontein. No attempt had been made to take them on to Paardeberg. They began work on April 14 at Sussex Hill, 2½ miles south of Bloemfontein, and in 46 hours tapped a supply of 11,500 gallons for 24 hours, which served the men and horses at Sussex Hill. Details relating to the boreholes sunk in and around Bloemfontein are given in Appendix VIII. Their yield of water seems, however, in some cases not to have lasted very long. (See paragraphs 3 and 18, Colonel Notter's Dissenting Statement.)

CHAPTER V.

Dysentery and Enteric Fever at Pretoria.

It would serve no useful purpose to follow the sickness of the Western Army, as a whole, further than Bloemfontein. That which occurred at Modder River, Paardeberg, and Bloemfontein, as regards dysentery and enteric fever, occurred in other places in a minor degree, the causes being similar.

At Kronstadt the troops suffered to a considerable extent owing to the pollution of the water, first from the Boer camps, and afterwards from the drainage of some of the British camps.

The season of the year for dysenteric and enteric fever was, fortunately, waning, otherwise the same calamitous prevalence would have been repeated. As it was there was a considerable amount. Dr. Dodgson, later in the year, isolated the enteric fever bacillus from the river water. At this time the use of the river water for soldiers was given up.

At Pretoria the season was still further advanced, and these diseases, though continuing, declined.

Pretoria is supplied with excellent water obtained from springs, and the water is conveyed into the town by pipes. For the amount of water used the pipes are somewhat small, so that the pressure is insufficient to give a constant supply to the higher parts, and in many portions of the town the inhabitants still have wells. The distribution of the public water supply is limited to the town. Outside its limits the inhabitants depend on shallow wells or superficial land springs. A portion of the troops, including the columns which were constantly coming and going, had, as a matter of necessity, to be encamped outside the town, and were dependent on wells, land springs, and spruits for their water supply. The wells and springs, which gave a pure

supply under ordinary conditions when there were a few inhabitants, only exceptionally retained their purity when masses of troops successively occupied the ground. At and in the vicinity of Pretoria railway station, the Commission, on arrival early in October, found two water supplies, one of which was labelled not for drinking purposes. Large bodies of troops and native followers coming from and going to Pretoria bivouacked in and around the station all night to be ready t o start as soon as possible on receipt of orders. A notice not to drink the water was useless. First of all, at night the notice could not be seen, and secondly, during the day the soldier in a hurry was not to be deterred drinking from an unguarded water pipe because of a notice that it was not for drinking purposes, while for the natives that accompanied the troops, and who also take enteric and dysentery, the notice was useless, because they could not read it.

The history of this double supply is peculiar, and it is an example of the necessity of having a special agency to control and supervise the execution of works relating to health in the army. A fortnight previous to our visit, Dr. Turner, who had recently been appointed by Lord Roberts, Medical Officer of Health of the Transvaal, during one of his earlier inspections of the town, accidentally discovered that there were two separate sources of supply to the railway station, and that only one tap received its supply from the Pretoria waterworks, and all the others from a spruit liable to pollution, the latter having been put up since the military occupation of the town. He further discovered that a rest camp which had been formed close to the station on the side more remote from the town, and under the hill, was supplied from tanks on the hill. These tanks were supposed to be filled during the night from the town main, but it turned out that they were filled from the spruit. (*Vide* Dr. Turner's reports in Appendix.) It was arranged that two 600 gallon tanks should be put up to supply the station with pure Pretoria water, and that the taps supplying spruit water should be removed. As stated, the Commission, on its visit of inspection with Dr. Turner, found that only the first portion of the contract had been carried out.

At Pretoria the Commission were enabled to make some careful enquiries into the causes of dysentery and enteric fever. A continued prevalence of dysentery, enteric fever, and of diarrhœa among the soldiers occupying one of the western forts is instructive; the fort is 500 feet above the surrounding country, away from the effects of dust storms or of the dust caused by traffic; the latrine and drainage arrangements were such as to favour a quick removal of the excreta and salliage, there was no pollution of the soil, and there was no question of flies contaminating the food, the water supply was also protected from dust or other pollution in a large covered masonry tank in the fort. Notwithstanding this, the enquiry seemed to point to the water as the cause, and on further investigation into the source from which the supply was derived, it was found to be pumped up from an open and shallow well, subjected to excremental pollution, and supplied by a cutting from a pool from a land spring in which there were the remains of several dead oxen and horses. After protection of the source and purification of the water the prevalence of these diseases stopped, though the season for their special prevalence had just begun. (See paragraph 4 of Colonel Notter's Dissenting Statement.) More easterly, and down in the valley, and nearer Pretoria, there was the Pretoria Leper Asylum, which obtained its water supply from a deep well boring properly protected, and throughout the period during which dysentery and enteric prevailed in the fort and in the camps, there was none in the Asylum, either among the lepers or attendants.

There was a fatal intestinal epidemic among horses in one of the civil veterinary hospitals situated lower down in the valley, nearer to Pretoria than the Asylum, and which Dr. Theilor, the able veterinary surgeon, attributed to the water which these particular horses had been drinking. They drank from a spruit or small stream, which on inspection was found to be polluted by dead oxen and horses, and which received the drainage from trenches in which hundreds of horses which had died of wounds or of disease had been buried, the pollution of the superficial land springs near these trenches, and of the soil and streams after the rain was intense. Long trenches, 6 to 8 feet wide, and 6 or more feet deep, were flooded with water at the time of our inspection, so that when the animals were buried the subsoil water became a putrid

infusion, and a danger to every stream it drained into. The smell was very offensive, and could be detected on the windward side for a long distance. Below the Veterinary Hospital the polluted stream joins the Appies River, which flows northwards through the poort which is formed by a cleavage between a range of hills. The Appies River starts from the south-east of Pretoria, and in its course it receives the drainage from a part of the town, and passes near a filthy native location. In addition to this usual pollution it was further polluted by dead horses being disposed of in an insanitary manner near its banks. (See paragraph 5 of Colonel Notter's dissenting statement.) The troops which guarded the poort, and also were encamped north of the poort, suffered heavily from dysentery, enteric, and diarrhœa. This was ascertained from the following notification which Col. Gubbins, P.M.O., kindly made use of at the suggestion of the Commission :—

Daily Return of Sick from Enteric Fever, Simple Continued Fever, Diarrhœa, and Dysentery (Regimental Units only).

Date.
Name and situation of camp.
Regiment and company.
Number.
Name of soldier in full.
Age.
Nature of illness.
Name of hospital sent to with date.
Remarks.

From statements made by the patients it was evident they had been drinking from some special spring. On investigation it was found that Pretoria water was brought in a cart to the nearer camp, but at the outposts at the further side of the poort was what the soldiers called a spring, but which was really a leakage of some of the river water through a fissure in the ground after it had passed close to a burying place for excreta.

The further camp had also had Pretoria water brought in pipes to the eastern side of the camp, but as it was a large camp many of the soldiers in the western portion still obtained water from the Appies River and from the spring. The history connected with this water supply is also interesting and instructive. In November a sanitary officer was specially appointed for the western district of Pretoria. In November, after an inspection of the sanitary arrangements at Daspoort, he reported that the drinking water for the camp at Daspoort was river water which flowed through a Kaffir location after having received all the surface water of the town, and on the banks of the river near the camp was a latrine. He made the following recommendations :—

(*a*) That the water for drinking for officers and men be boiled.
(*b*) That the Pretoria water supply be laid on.
(*c*) That if the foregoing is not possible, that wells be dug and windmills erected.
(*d*) That a sentry be placed on the so-called spring in the river to prevent men drinking the water in an unboiled state.

The Principal Medical Officer for Pretoria endorsed these recommendations, and as a result the town water was brought into one part of the camp at great expense and in some cases the water was boiled, but no constant guard was put on the spring to prevent the soldiers from drinking foul water. The recommendation was not carried out, being evidently thought to be unimportant, yet the omission cost many more times the men than would have been required to guard a dozen such places. (See paragraph 6 of Colonel Notter's Dissenting Statement.)

Attention to detail is one of the requisites of success in sanitary matters, and if the sanitary officer in this case had been a staff officer, the suggestions after meeting with the approval of the general would not have been issued as recommendations or instructions to be possibly revised at some time by the commanding officer, but as orders of the general to be carried out.

The same inattention to the quality of water drunk is recorded in a report by the same sanitary officer, Lieutenant-Colonel Nicholson. In November, 1900, that is five months after the occupation of Pretoria, he records that the examining guard on the way to Daspoort made use of drinking and cooking water which he considers to be very foul. "There is a hole, termed by some of the men a well, dug about a yard from the edge of a spruit, and at its level, and about 50 yards from where dead horses are buried. The nearest camp to it is that occupied by the guards, but from what I can find out the guard comes from different regiments. As the water is no other than the dirty contaminated spruit water, I would recommend that a cart be provided to bring water from some other source."

The incidence of dysentery and diarrhœa also bore heavily at one time on the men at the howitzer fort on the south-east side of Pretoria, until it was discovered that the conductor was burying carcases immediately above the source of the water supply, which was taken from a spruit or small stream. On the discontinuance of the burying and the provision of a new water supply the prevalence disappeared.

In December a number of cases of enteric fever among the troops at Pretoria and in one of the hospitals was distinctly traced to the drinking of mineral water obtained from a particular factory which prepared its waters from a polluted well. That the soda water and aërated waters, supplied to some of the hospitals were not always above suspicion, is evidenced by the fact that Dr. Washbourne, Physician to the Yeomanry Hospital, sent one of the bottles to the Principal Medical Officer's Army who forwarded it to the Commission for analysis. An examination showed that the water was contaminated with organic matter and coli bacilli were present. The supply was stopped.

A visit to the factory disclosed the premises to be in a gross state of filth, and the process of manufacture to be conducted in a most uncleanly manner.

This incident, together with the results of some later analyses made by the Government analyst Dr. W. Schmitz Dumont, led to a special investigation into the condition of the ice and mineral water factories in town, many of which had to be closed until the District Surgeon of Pretoria was satisfied that the supplies were safe for use.

It was during this investigation that an inspection of the premises of one factory showed that the ice, though prepared from Pretoria water, was being manufactured under very crude conditions in the same compound as beer, and that it was liable to filth contamination, and that the mineral waters were prepared in another factory close by, but with well water which was obviously open to contamination, owing to its being situated in the garden of the premises at the bottom of a slope down which stable and cowshed refuse and surface filth were washed by the rains and flowed into the well. A raised corrugated-iron cover was put over the well but, like most South African wells, the mouth was not protected by a coping, so that notwithstanding the cover the drainage of the premises above the well had free ingress during the rains. There was moreover no steining and the well was about 30 feet. An investigation in which we were assisted by Dr. Turner into the distribution of the aërated water sold by the company, showed that there was a heavy incidence of enteric fever among its consumers in the town, while in the race-course hospital, which received the Trevenna supply for its staff and a supply from another company for its patients, it happened that 27 per cent. of the staff were attacked, and this at a time when the hospital was free from enteric fever, no fresh patients having been admitted for enteric for a period of two and a-half months. Two fresh cases were, however, admitted into the race-course in the first week of December from the outside, and it appears that both of these also drank this soda water. An interesting point in connection with this outbreak is that the supplies for the staff of the hospital were first purchased on October 26, but did not come into use for a day or two, and that the first case of typhoid fever dates from November 14th.

Near the Pietersburg railway station at Pretoria where troops were stationed and where the canteen was supplied by the Trevenna Company, the medical officer in attendance reported 10 cases of typhoid between December 4 and January 8, four of these terminated fatally. The water of the well was

examined bacteriologically and a colon and typhoid bacillus isolated. The result of this examination is given in Appendix V.

At Pretoria some experiments as to the possibility of flies contaminating food were made in the depôt in which the non-infective excreta of patients of the hospital were kept until removed by the contractor. The experiment consisted in placing vessels of milk previously sterilised uncovered and covered with muslin in different parts of the depôt. Only four experiments were made and on each occasion six vessels were employed, three being covered and three being left uncovered. In two experiments one of the vessels out of the three uncovered contained flies and on examination of the milk the bacillus coli communis was isolated, while from the milk of the other vessels covered or uncovered in the four experiments no bacillus coli could be obtained. The evidence of the flies contaminating the milk was positive.

CHAPTER VI.

Dysentery and Typhoid among British Prisoners at Waterval.

(See paragraph 7 of Colonel Notter's Dissenting Statement.)

Waterval is situated within the malarial belt 14 miles north of Pretoria. It was to this station that the British prisoners were removed from the race-course in Pretoria where they had been previously encamped. From time to time more prisoners were added until in May they reached the number of over 4,000. They were released in June when Pretoria was captured. The camp was pitched near the confluence of two rivers, the banks of which are low-lying and are subject to flooding as the rivers rise. It was on the northern slope of the hill facing the two rivers that the camp was erected. Four large sheds at a distance of 9 yards apart were put up and were evidently intended to protect the men from the rain, but as they were built across the slope of the hill and no arrangements were made to carry off the flood water these sheds were useless for protection. During the rains—and the prisoners were encamped here during the rainy season—the flood water came down the hill bringing with it the refuse which had been placed in heaps above the camp, invaded the first shed, flooded it, and then passed on to the other sheds partly carrying with it and partly depositing the impurities which it met with in the camp and flowed down into the river. The water supply was pumped up from the river thus polluted into tanks in the camp, but as the banks of the river were used as a latrine by the Boer guard the drinking water was further polluted. But this was not all. The latrine trenches of the camp were about 6 feet wide and 8 feet deep and only a short distance from the camp sheds. The trenches during the heavy rains got flooded and overflowed and the contents were taken with the surface drainage of the camp down the hill into the drinking water. These conditions were bound to give rise to disease. Already in Pretoria there had been among the prisoners a few cases of enteric fever and the infection was transferred with the prisoners to Waterval. The sickness among the British prisoners at Waterval is a melancholy example of the evil results which may happen to a fine body of men when placed under insanitary conditions, and at the same time insufficiently fed.

Waterval is a malarious locality but the type of malaria is mild and non-fatal. The malaria could easily have been avoided by the selection of a non-malarious site for the camp. But the ill-effects of malaria on the men were insignificant to those caused by the insanitary conditions under which they had to live.

During the five and a-half months that the soldiers were encamped at Waterval there were amongst them 294 cases of enteric fever, 122 cases of dysentery, 305 cases of malarial fever, and 119 cases of sickness from other causes, making up a total of 840 admissions from sickness. During the same time there occurred 46 deaths from enteric fever, 4 deaths from dysentery, 1 death from malaria, and 11 deaths from other causes, or a total of 62 deaths.

The following tabulated statements give the number of sick and number of deaths month by month :—

Sickness.

Months.	Enteric.	Dysentery.	Malaria.	Other Causes.	Remarks.
December	3	2	2	13	
January	19	40	7	16	
February	70	28	25	15	Dr. Von Gernet sent out on February 24 to take medical charge of prisoners
March	119	14	30	15	
April	57	8	92	24	
May	25	23	124	27	
June	1	7	26	9	
Total	294	122	305	119	

Mortality.

Months.	Enteric.	Dysentery.	Malaria.	Other Causes.	Remarks.
December	—	—	—	—	
January	—	1	—	1	Death rate from typhoid on typhoid admissions 15·6
February	4	—	—	1	
March	13	—	—	2	
April	18	—	—	3	
May	7	2	1	2	
June	4	1	—	2	
Total	46	4	1	11	

It will be noted that dysentery and enteric fever became very rife in January. In that month Dr. Haylett, who had been appointed Medical Officer to the Waterval Hospital under Dr. Veale, reported the state of matters to his Chief, but Dr. Veale appears to have taken no very active measures to mitigate the sufferings either of the prisoners or of the sick. A few unimportant alterations were made, and these were chiefly directed to the improvement of the hospital rather than to the improvement of the sanitary condition of the camp. A fresh and additional water supply was also obtained by digging a trench near the river and intercepting the underground water flowing towards the river, but even this new water supply was subject to pollution. Dr. Haylett, finding that his requests were not attended to by Dr. Veale, resigned, and in a short time Dr. Von Gernet was appointed. Dr. Von Gernet took over charge on February 24, and in his first inspection of the camp and hospital thus describes the state of things:—"I found the prisoners housed in sheds built of corrugated-iron, open towards the front, and, by reason of the corrugated-iron sheets being old, letting in the rain through the roof. The central road being higher than the floor level of the sheds, the rain drained into them. The men, consequently, in wet weather (and this was the rainy season) were lying in water. Each man had one blanket. There were no waterproof sheets and the men were lying on the bare ground. The streets were in an indescribably filthy condition, rotting animal and vegetable refuse, and even human excrement, lay freely all over them, and the stench was awful. The latrines consisted of trenches 7 or 8 feet deep within 50 yards of the night camp in which the men slept. The heavy rain filled these trenches and the contents were floated all over the place. The supply of drinking water was insufficient. It was stored in large tanks, and I found men were in the habit of drinking indifferently from the drinking water tanks and washing water tanks, and also of using the drinking water tanks to wash their clothes in. The washing water was quite unfit for drinking. There was no organisation or discipline in these matters. The prisoners' clothes were in rags, some being without trousers, others without coats or boots. The food supplied to the men was quite insufficient. Meat was only issued twice a week, and then only ½ lb. at a time. The result was that the men became very weak and liable to disease, and I had to admit

several men to hospital simply from weakness from want of proper food. They had plenty of flour. Men washed themselves and their clothes in the street, bringing the water from the tanks (which were in the night camp) in buckets. This practice tended, of course, to the spread of disease. The building used as a hospital was satisfactory. The furniture was absolutely unsatisfactory. For instance, with over 60 in-patients and 20 orderlies there were only 21 bedsteads, 11 mattresses, and 49 blankets. I found nearly all the sick lying on the bare floor without bedding or pillows. There were 41 typhoid cases in the hospital and no suitable medicines whatever, that is, no medicines that I would prescribe for typhoid. The food supply for the hospital was quite inadequate. The ration for a typhoid case (Diet 1) was supposed to be one bottle of beef-tea made of 1 lb. of meat; two bottles of milk. Frequently no meat was received, and, consequently, no beef-tea could be made. The milk seldom arrived.

"Diet 4 was supposed to be :—
"One bottle of milk;
"One bottle beef-tea (as above);
"Arrowroot, sago, biscuits, and rice;
"but the meat and milk came irregularly."*

Dr. Von Gernet was not satisfied with writing to Dr. Veale, but went direct to the President of the Committee ("Bewaaking Krijgagefangemen") and informed him as to what his inspection had revealed. The same afternoon the Committee was summoned. Dr. Veale's connection with the hospital ceased, and Dr. Von Gernet was placed in sole charge. With the Committee's consent he carried out the following improvements :—

1. The streets were levelled by Kaffirs, surface drains were constructed, and three cross streets were made. These alterations secured the dryness of the sheds.

2. Wheel-barrows, shovels, and brooms were provided and the soldiers cleaned the camp, depositing the refuse collected in the barrows near the fence of the camp, from which it was removed in carts by Kaffirs superintended by a sanitary inspector. As the refuse was deposited above the camp a ditch was made outside the camp to keep off the flood water.

3. The trenches in the night camp were disinfected with chloride of lime, and in their place were erected eight latrines, each containing six to eight buckets, which were emptied, cleaned, and disinfected every morning. The day latrines were located well away from the sheds. Two urinals were also placed in the night camp.

4. Bags and wire were given to each prisoner who asked to make himself a hammock or stretcher to sleep on. About 1,000 men slept on hammocks, a large number on stretchers, the rest preferred sleeping on the ground. A blanket was given to each man, and clothes and boots were obtained for about 1,000 men.

5. An increase of the quantity of meat allowed to each man was obtained, two being granted weekly instead of one, later 3 lbs. were obtained from the English Committee in Pretoria, of which Mr. Wood was Chairman. It was not until about March 20 that the second 1 lb. was granted, and it was not until some time in April that the prisoners received 3 lbs. weekly.

6. Water was pumped up to 10 tanks in the night camp, six were intended for washing purposes and were filled by pumping from the river. Four were intended for drinking and were filled by pumping up from an open ditch or well. These tanks were labelled for drinking and for washing, but the men drank from all indiscriminately. The pumping from the river was stopped, and the water from the well was pumped up to all the tanks. The tanks were also opened and cleaned out, and in some were found rags which had dropped in during the process of washing clothes over them. The water from the supply well was analysed by Dr. Smitz Dumont and found to be polluted, in consequence of which a second well was sunk on the other side

* Extract from proceedings of a Court of Inquiry assembled at Pretoria on June 11, 1900, and following days for the purpose of inquiring into the treatment of British prisoners, but more especially the treatment of sick prisoners in the hands of the Boers in and near Pretoria.

of the river. Owing to the fact that a sufficient supply of water could not be obtained from this second well, the first well was cleaned out and arrangements made to prevent its pollution by surface drainage. It was also contemplated to filter the water, but the prisoners were released before the filtration of the water was carried out. These improvements were introduced early in March. They took some little time for their completion. The change from the river water was effected in February, and made an immediate impression on the prevalence of dysentery. In March the typhoid reached the large number of 119 cases, but by April this was reduced more than one-half, viz., to 57, and in May to 25. In the first week in June there was one case of typhoid fever. The Appies River water was brought into a large tank to be used by the men as a swimming-bath. It is likely that some of the men drank this water before it passed into the tank and got dysentery from it.

The results obtained by the sanitary measures introduced by Dr. Von Gernet were excellent. When he took over charge there were some 2,000 prisoners, whereas in May there were 4,000, yet notwithstanding a doubling of the population in the camp, the epidemic of typhoid and the prevalence of dysentery rapidly gave way, though the appliances at hand were not of the best. This unfortunate epidemic among the British prisoners at Waterval is an object lesson of the highest importance. It shows the rapidity with which sickness will arise under gross insanitary conditions, and the quick amenability which the sickness exhibits as soon as proper preventive measures are introduced to remove these insanitary conditions.

Lord Roberts, in his despatch to the Secretary of State for War, refers in eulogistic terms to Dr. Von Gernet's services in the amelioration of the condition of the patients. (See paragraph 7 of Colonel Notter's Dissenting Statement.)

CHAPTER VII.

Sanitary Condition of Camp.

The most conspicuous sanitary defect almost everywhere in this campaign has been the impurity of the drinking water, either because of the difficulty in procuring for the men a pure water supply or, in the event of that proving impossible the general carelessness in regard to systematic measures of purification. This was due in many instances to a want of knowledge of the principle, and in many cases to a want of appliances. Frequently water was shown to us as being excellent which a little knowledge in sanitary matters would have at once condemned as being dangerous. We have seen guards placed on the water which the soldiers should drink, but we have never seen guards placed on water which is dangerous and which ought not to have been drunk. (See paragraph 6 of Colonel Notter's Dissenting Statement.)

The selection of the water supply for a large body of troops was generally in the hands of a staff officer whose training scarcely fitted him for this important duty. This arrangement is the remnant of an old system in the Army which had its origin at the time when less was known regarding the importance to the health of the men of the kind of water drunk. The purification of the water is dependent on the views of the officers of the regiment. It was a very noticeable fact that, as a general rule, the water was taken as it was found with no discrimination as to its quality or liability to pollution. When the water happened to be good and not polluted it was an accidental advantage to the troops, but even this good fortune was often marred by a want of care in protecting the supply from pollution. At Barberton for example which is a town free from dysentery and typhoid fever on account of the purity of its water supply one of the best methods was adopted to render it impure. The water is supplied from a spring in the hills, is conveyed to a closed reservoir in pipes and then distributed in pipes to the inhabitants. We found on inspection a picket encamped on the top of the reservoir and the soldiers of the picket obtaining their supply of water by taking off the ventilator and dipping their cans into the reservoir. When

this state of matters was brought to the notice of the general it was immediately remedied. At Waterval Boven within a few feet of a well reputed to supply the finest water of the locality, and for which the soldiers came a long distance from the camp, a sow and seven young pigs were located on one side within a few feet of the well and some 20 natives or more with their known filthy habits were permitted to remain living in premises close to and above the well. The premises occupied by them were filthy and the drainage ran towards the well. There was another well at the station which at one time had a reputation for giving good water, but the well had not been carefully reserved for drinking purposes only. The washing of clothes in its immediate surroundings had been permitted, and as it was inadequately protected the water got polluted with surface drainage. At Machadodorp the well which was believed to supply the purest water had on one side some open trench latrines full of excreta within 60 feet of it and on the other surface drainage soaking into it.

At Naauwpoort an excellent supply was pumped up from a well into a tower which supplied a part of the forces encamped there. It was considered necessary to guard this supply so the well and pumping arrangements were placed inside a blockhouse. On inspection of the blockhouse it was found to be used as a latrine, not more than 8 feet from the well. (See paragraph 8 of Colonel Notter's Dissenting Statement.) At Rosmead there was an excellent supply of pure spring water for passing columns, but an inspection showed signs of human defilement on the sides of the spring so that a shower of rain would have contaminated the water.

These are a few instances out of many observed in which, owing to the absence of a jealous guarding of the water supply, a pure supply ran the risk of becoming impure.

On the other hand, when the water was inferior or liable to pollution no very great efforts were made to improve the quality. The matter was viewed as one of the exigencies of war which it was impossible to remedy *instead of as a serious difficulty which under any circumstances must be overcome.*

Though many regiments succeeded in taking precautions under the greatest difficulties yet it was the general exception for the water to be filtered or boiled. (See paragraph 9 of Colonel Notter's Dissenting Statement.) This statement applies not only to troops on the march where the difficulties are peculiarly great, but also to troops that have been encamped for weeks in the same place. It was, however, a noticeable fact that field hospitals and bearer companies succeeded in supplying themselves with pure water. Though this absence at any attempt at purification was the general rule there were many exceptions. At Ladysmith where the water from the Klip River was muddy and contaminated, some of the field hospitals made use of the wood ash waste from the cookhouses and used it as materials for filters. The wood ash most effectively cleared the water and rendered it fit to be filtered through a Berkefeld filter. By this method a pure water supply was secured for the hospitals from one of the most uninviting and polluted waters. Such was the success of this process that General Sir George White in Orders drew the attention of commanding officers of regiments to the system adopted. Some officers, moreover, especially belonging to the Natal army were very particular even on the march as to the character of the water and its purification before being issued to the men. The usual arrangement was one filter for every 100 men, so that in a regiment of 1,000 or 1,100 men there would be 10 or 11 filters. We found the Liverpool Regiment particularly careful in this respect. The arrangement was to strike off two to three men under the armourer-sergeant to look after the filters. At the beginning of the march the men had their water-bottles filled with tea. On arrival in camp a source of water supply was carefully sought out and a spring if possible selected. In the meantime the filters had been unpacked, and as soon as the water-carts arrived with water the water staff began work, biscuit tins being used for storing the water. The filtration was continued as long as the regiment was in camp. When the water was muddy it was cleared by a rough filtration before attempting to use the Berkefeld filters. The filters were carried by the regimental transport. Here was a system put into practice on the march from Laings Nek to Machadodorp, including three battles on the way, and the system found perfectly successful and feasible.

The men were not permitted to drink any water they liked, but an ample supply of water was provided for them, while an organisation, special in its character, was set apart for the purification of water. The staff so set apart were relieved from other regimental duties, so that there was not the slightest difficulty in the work being performed. If any fighting had to be done the men were available for that purpose. It is only under a system similar to this that the purification of water can be properly effected. If each man has to purify the water himself before he drinks it as is the arrangement in many cases there will be no purification, or if the work of purification is added to the duties of soldiers who are already fatigued by outpost or other duties it will not be performed Filters will then be broken, lost, or thrown away.

It has already been stated that the troops when on the march, unless they are following the direct line of communication, are less liable to dysentery and enteric than those who are stationed in camps, whether temporary or permanent. The reasons are that troops well away from the line of communication seldom encamp on ground which has already or previously been occupied, they daily occupy fresh camping grounds, and they obtain water which is comparatively pure and has not been subjected to the pollution which almost invariably occurs when troops are successively occupying the same ground. Everywhere on the line of communication we had evidence laid before us of troops arriving at night and discovering in the morning they had encamped on ground rendered filthy by previous occupation and that a polluted water supply was an ordinary occurrence. On some lines the water supply was better than others. All along the Koomatipoort line of railway from Pretoria to Koomatipoort the Netherlands Railway Company had provided at the stations for the purposes of the railway excellent water-tanks into which water was pumped from rivers or reservoirs near at hand. None of these water services were above suspicion, but, as a rule, they were a great deal better than in many places. The water was mainly intended as supplies for the engines, but in order that it could be used by the employees of the railways the stations and houses in which the employees lived were provided with Pasteur-Chamberland filters, and all drinking water was thus subjected to domestic filtration. These domestic filters were hardly adapted for the needs of the troops passing through, and no special arrangements on a large scale being made at the stations to provide them with purified or filtered water they had to drink the water as it was, and as the quantity was often insufficient, the engines having to be the first supplied, the water from the nearest well or streamlet was taken. Fortunately this advance was made at a season of the year when typhoid fever is at its lowest. If it had been made three months later the army would have suffered heavily from enteric fever and dysentery and the cause would have been the absence of a sanitary service and sanitary appliances.

Surface waters in South Africa except in out-of-the-way places are seldom pure.

The *water carts* in use are relics of the time when quantity and not quality of water was the chief object for which they were provided. They do not even fulfil the purpose of supplying a sufficient quantity of water, and as regards the quality of the water it is often not much superior to that in the stream or pond by the wayside and on occasion it is inferior. The soldier often gains nothing in the way of safety by drinking the water from the cart. Water was carried in various kinds of receptacles of different sizes, some of which were large wooden barrels capable of holding 80 gallons, others small barrels on mules, and others *mussuchs* on mules. The most usual was the iron water cart which holds 120 gallons and weighs about a ton. Two are allowed to a regiment but in this campaign many have only possessed one.

A regiment when marching counts with followers usually about 1,000 men. At the most, therefore, when there are two carts which hold each 120 gallons of water the total quantity of water amounts to 240 gallons which is considerably less than 2 pints per man. The thirst of the men sweltering along under a burning sun will not be assuaged by such a small quantity of water, and they accordingly seek in the pools they pass the quantity of water they cannot obtain from the water cart. The quantity is inadequate under any circumstances. It is important that each regiment should be provided with four water carts, the regiment is not infrequently broken

up into four parts stationed in different places, and it is essential that each unit should possess its water cart. In this campaign there have been parts of regiments without carts, and the water for cooking and drinking had to be obtained in kettles and sometimes from a considerable distance. The result as pointed out by the officers is that there is no storage of water, and consequently no time either for boiling or filtration even if the means for these methods were available. It is desirable to substitute a cart less heavy and it is imperative that the cart shall supply potable water from its taps.

There have been individual efforts among some of the military officers to solve the problem of supplying sterilised water to a portion of the troops under their charge. For instance, the C.R.E. at Maritzburg erected more than two years ago at the fort at Maritzburg a Maiche's steriliser, which supplies 800 gallons a day, to the married quarters. The steriliser is placed in a small closed tower which was formerly used for stores: on the roof is a supply tank from which the water is conveyed to the cylinder of the steriliser which is longitudinally chambered, and from thence it is conducted to the vessel in which the water is heated by a kerosene lamp. The heated water is then conducted back to the cylinder, and in passing through this in a small pipe loses its heat to the incoming water, so that when it flows from the cylinder into the receiving tank it is cold and fit for drinking. From the receiving tank in the tower the water is conveyed by a pipe to a 400-gallon tank which is for the use of those who take the trouble to fetch the water. The cost of the steriliser was £56, and for its use it consumes 5 gallons of kerosene a week. Its maintenance is about 9*d.* a day for 800 to 1,000 gallons a day. The water was tested and found to be sterile. This process possesses an advantage over boiling in that the air in solution is not lost, and it has not the insipid taste usually belonging to boiled water. The principle is to sterilise under pressure, and a valve in front of the steriliser regulates the flow according to the temperature attained, the higher the temperature the quicker being the flow, and the lower the temperature the slower the flow. If the temperature falls below 212° the flow stops altogether until the temperature rises. The valve had during the last six months only been touched once. The oil lamp was filled night and morning, the door was then locked and the steriliser was left to work automatically.

A more general system of sterilisation of the water supply has been practised in the camp at Ladysmith since January, 1901. The Maiche's steriliser was first brought into use, but it did not give a sufficient supply, there being some 2,000 Boer prisoners to be provided for in the camp in addition to 500 soldiers, 100 followers, &c., and 100 sick in the hospital. Colonel Sim, C.R.E., Northern Natal, describes them in the "Royal Engineers Journal" of April 1, 1901, and his description with plans are in Appendix VII. There are six tanks, and the principle is to sterilise the water in each by means of steam brought in pipes and which is obtained from the traction engines used at night for the electric light dynamos to light the camp. When the water has cooled and the mud precipitated by the addition of alum, it is drawn off into a service main and distributed to different parts of the camp.

At the same time as this sterilisation of the water, a very excellent dry earth system of latrines was introduced into the camp with the result that the latrines are cleanly, free from flies, and free of offence. Coincident with these sanitary reforms at Ladysmith there has been a marked absence of local enteric and dysentery which was maintained at the end of September, 1901, the date of the second visit of the Commission.

Another method of obtaining large quantities of water, viz., by boring has been referred to. Between November, 1899, and August, 1901, 107 boreholes have been sunk for the military authorities, and in 74 water was found (*vide* Appendix VIII). The section of three of these wells respectively at Enslin, Bloemfontein, and Springfontein is given. The Karoo in Cape Colony and nearly the whole of the Orange River Colony, nearly up to Kronstadt, consists of much the same formation, shale and sandstone with occasionally limestone, dolorite cropping up frequently.

Prospecting for water by boring commenced in the Cape Colony in the year 1890. By 1893 the work of prospecting for water had already begun to be so much appreciated by the agriculturist and stock farmer that hundreds

of applications for the use of the Government drills were received, and from that time the operations of the water boring branch have steadily extended, until in 1900 there were 32 drills employed in boring 485 holes, of which 366 gave water and 326 over 1,000 gallons a day, with a total yield of 3,759,266 gallons per diem. Of this amount 1,392,682 gallons flowed at the surface. One borehole in the Colesberg district yielded 76,000 gallons per day of flowing water, and another in the Cradock division 78,000 gallons. Farmers pay the Government at the rate of 15*s.* per diem for a steam power drill and 10*s.* per diem for a hand-power drill, the Government providing a skilled Foreman, but the applicant finding labour, fuel, water and transport from the place where the machine was last at work. The average depth at which water is found in the Cape Colony is stated to be about 60 feet and the cost of the boring operations inclusive of the wear and tear of diamonds, machinery, &c., is about 12*s.* per foot. Altogether some 2,500 boreholes have been sunk by the Government drills since 1890, of which 75 per cent. have been successful in tapping water at a depth varying from 50 to 500 feet, the yield of water ranging from 1,000 to 50,000 gallons per day, and in some instances as much as 100,000. The holes bored are from $2\frac{1}{8}$ to 6 inches in diameter, and they are only lined when the formation is friable or soft or near the surface and before rock is encountered. The water generally stands in the borehole higher than where it is struck, but when it does not flow at the surface an ordinary deep well pump is used. Boreholes are generally sunk to a depth below where the water is struck in order to strengthen the supply. The drills used by the Colonial Government are :—

(1) Steam-power drills weighing about 5,000 lbs. and costing £500 which bore a $3\frac{1}{8}$-inch hole to a depth of 500 or 600 feet.

(2) Hand-power diamond drill weighing about 3,000 lbs. and costing £145, and boring a $2\frac{1}{8}$-inch hole to a depth of 300 feet.

(3) Combined hand-power diamond drill and jumper drill weighing about 4,000 lbs., and costing about £200.

All the holes bored are usually reamed out to $4\frac{1}{2}$ inches to allow of the insertion of the pump.

The engine employed with the steam drill is a Tangye pattern 2 horse-power, with a vertical boiler mounted on wheels with a disselboom for draught purposes. The boring rods vary in weight from $3\frac{1}{3}$ to 4 lbs. to the foot, according to the drill used, and measure $1\frac{11}{16}$th of an inch to $1\frac{1}{2}$-inch in diameter. It is estimated that the time taken to bore a 3-inch hole to a depth of 500 feet would be 50 days of 10 hours, and the cost involved would be 11*s.* to 12*s.* per foot. The cost of boring a hole 100 feet deep, with a hand-power drill, would be about the same as with a steam-power drill.

The average rate of progress when working is 10 feet per day, but the hole is abandoned if igneous rock is struck or when accidents occur which prevent the operations being continued. In most instances where accidents have occurred, however, the depth attained has been from 100 to 300 feet, or considerably beyond the average depth at which water is found.

The fuel used is coal, wood, or mest (cow-dung), one of which is usually obtainable, and the quantity of water required for working the drill is 200 gallons for the boiler and 300 gallons for the drill per diem.

The advantages of a borehole over an ordinary well are :—

(1) Freedom from surface contamination.

(2) Natural filtration of the water.

(3) Rapidity in sinking. The average progress of sinking an ordinary well of about 6 feet in diameter is about 3 feet per 24 hours, whereas with a borehole the average is 28 feet during the same period.

(4) A greater quantity of water is obtained by sinking a borehole than by sinking a well. In an ordinary well, when the superficial water is tapped, the deepening of the well is generally abandoned owing to the inrush of water being too great to allow to work therein, and consequently those who are searching for water have to be satisfied with the superficial supplies. The supply of water for an army is either on a large or a small scale. The first requires all the modern appliances known for quickly obtaining and purifying water. The second requires the water cart to be so arranged as to

supply pure water from whatever source it is taken. Whether in addition to the use of water carts supplying filtered water it is possible to have motor tanks, which shall supply sterile water, is a problem for the heads of the suggested health service. But with the tendency for motor traction to be employed in transport it is a matter for consideration whether this power could be used when sterilised water is required.

In all arrangements for supplying a potable water the carelessness of the soldier must be taken into account. It is also to be remembered that filters are useless and dangerous when left to untrained men, and that no boiling will be done if the process is left to the men themselves.

Latrines and Refuse Pits.

Among the regular troops as a rule, particularly those who have seen much service in India, great attention was usually paid to the cleanliness and position of the latrines and refuse pits with reference to their proximity to the camp and to adjoining camps. In some cases they were inconveniently distant from the camp, and were thus apt to defeat the object intended, viz., keeping the camp free of nuisance. A latrine placed at too great a distance is apt not to be used at night. Special arrangements were made by some regiments for movable latrines to be placed inside the camp for use during the night to avoid fouling of the ground in the darkness, and it was noticeable that these regiments were the healthiest. It was, however, difficult to estimate exactly the proportion of health that was due to this cause alone, because they were always regiments that were also very careful over their water supply. Other regiments, more especially some of the irregular corps, were not so particular, and sometimes the camps were far from being in a cleanly condition.

The position of latrines and refuse pits, in relation to proximity to kitchens and water courses, was not sufficiently considered. During rain proximity to a water course increases the risk of flood water passing from the latrines into the water course, while, in a country in which flies are almost a pest, nearness to a kitchen is a source of danger owing to flies swarming from the latrines to the food exposed in the kitchen or in the tents close by. The danger from flies exists even when the latrines are kept fairly clean which is seldom the case on these occasions. Such positions should be interdicted under all circumstances. There may be occasions in which, for military reasons, the standard distance from the camp or adjoining camps cannot be obtained, and then as long as the kitchen or water course is avoided the position may be considered to be not nearly so important as the condition in which the latrines are kept. A faulty position, under exceptional circumstances, can be completely counteracted by scrupulous care in regard to the cleanliness of the latrines. Faulty construction of the trenches, careless usage, and insufficient covering with earth were the most frequent defects. Except in standing camps it appears to have been frequently, especially where troops are rapidly concentrating, to be no one's concern to keep the trenches in a clean and sanitary condition, and that which was no one's business soon resulted, where large numbers were concerned, in a very unsatisfactory state of affairs.

Trenches of too great a width were seen in some places, and consequently the ground was apt to be soiled around the trenches. It is difficult to cover the excreta with earth under these circumstances. Trenches such as these, moreover, allow paper deposited in them to be wafted out by a strong wind and to be blown about the camp. They may lead also to further uncleanliness in the camp, because, when filthy, the soldiers, as opportunity occurs, use the nearest bank or donga, thus adding considerably to the danger to health from pollution of the soil of the camp.

Even when constructed according to regulations, the systematic covering of the excreta and paper was rare, hence even under fairly good conditions the trench, as a rule, at certain seasons of the year was teeming with myriads of flies, which afterwards transferred themselves to the tents and to the food and drink in the camp. Occasionally there were camps in which

the latrines were carefully covered with earth or with chloride of lime, with the result that there were no flies; but these camps did not always benefit to the full extent of their labours, because they were sometimes pestered by flies from neighbouring camps.

Covering the latrines, &c., with earth and the urinals with disinfectants is, under the circumstances related, of the highest importance, in view of the fact that in an army in which dysentery and typhoid fever exist, there are always a number of soldiers ill with these diseases who use the latrines and urinals, and who do not report themselves sick until it is impossible for them to go on with their duties any longer.

Disposal of Carcases of Dead Animals.

The disposal of carcases of dead animals has been one of the great sanitary defects of the campaign. In most cases there has been no quick disposal, and where there has been, it has been effected often in such a manner as to contaminate the purity of the streams and springs of the locality, and thus endanger the health of men and animals that might drink of this polluted water. One method was to drag the dead animals some distance from the camp and leave them in a valley and let them putrefy; another was to bury them near the place they died, small mounds indicating the place of burial, and so little were they covered that the first heavy shower of rain partially exposed them; a third method was to dispose of them in trenches deep and wide, which would contain large numbers, and cover them well with earth. In selecting the site of these trenches the topography of the country around was seldom considered, or its possible relation to the camp, town, or village. As with the water supply, so with the proper disposal of dead animals; no one specially seems to be responsible for the control and supervision of these matters. The disposal of carcases at Pretoria has already been mentioned. Similar defects were seen elsewhere in many places. At Maritzburg the contractor employed selected a site on the banks of the Umsindusi. There were two trenches, one of which was 150 feet in length, 9 feet wide, and 9 feet deep, dug parallel to the river, the nearest point being 12 feet from the water of the river and the farthest not more than 20 feet. Horses were to be seen piled up to within 2 feet of the surface. The surface of the filled-in trenches were sunk about a foot, and the smell was strong. A little lime was sprinkled here and there, but at the most not more than a few lbs. Below the site at which several horses were buried the river flows through a location, the inhabitants of which are accustomed to take their drinking-water from the river. The Commandant, immediately his attention was drawn to the practice, put a stop to it, and insisted on the selection of a more suitable site.

The burying of carcases near streams, which was one of the commonest practices, is most objectionable and dangerous, the whole subsoil water being in many places polluted by this means. The stench from some of the trenches in which the carcases were buried was very great, while the method of burial was often of the worst description.

The disposal of carcases of dead animals is surrounded by great difficulties. If the carcases are left on the ground unburied, and they are not removed a long distance from the camp, the stench is sickening, and the number of flies attracted enormous. If, on the other hand, the carcases are buried, the stench is lessened, and the number of flies less, but the subsoil water is liable to pollution, and during the rains in such a country as South Africa the springs, which are mostly land springs, become polluted.

Burning is no doubt the most effectual method, but it requires fuel, which is not always procurable. In the case of want of fuel the dangers could at least be avoided by selection of suitable sites for burying, and having the carcases buried in a proper manner and under supervision.

It is, however, not only the dead animals which add to the unhealthiness of a camp, but the living animals, healthy and sick, when improperly located, contribute in a measure to this end. Remount depôts, transport animals and horses are often located in a haphazard manner, the site selected being the

worst possible to the troops, and yet for no particular reason. For instance, over 3,000 horses, a large number of which were sick, were brought into Maritzburg and encamped in a limited space about 300 yards from the hospital and from the fort. The horses brought with them a plague of flies, and those which died, not being immediately removed, produced an offensive stench, and they were buried as already described.

It was only after numerous complaints by the Army Medical authorities that the nuisance was removed, but there was a tendency to argue that these conditions caused no harm. These horses ought not to have been brought into town, and if it were important for their safety that they should be, there was no reason for encamping them close to the hospital and the men's camp, and still less reason for delay in removing those that died.

The necessity of some controlling authority who views these matters from a sanitary standpoint, and from the aspect of the health of the men and of the animals themselves, is obvious. It was the same at Bloemfontein, where remount depôts were placed near hospitals without any urgent reasons, and the whole surrounding neighbourhood was pestered with swarms of flies and subjected to preventable nuisances.

The conditions giving rise to the insanitary state of large camps generally may be summed up as follows :—

(1) Surface supplies of water and their liability to pollution by dead animals or excremental matter, or surface drainage, or all combined.

(2) The imperfect and ill-considered disposal of carcases of horses and oxen.

(3) Defective covering of latrines, proximity of litter, manure, and refuse heaps, and fouling of the ground with urine and slop water, causing risk of infection of food from flies and from the possible contamination of boots, clothes, utensils, and hands.

(4) The absence of organised establishments for the cleansing of camps that have been occupied, the absence also of arrangements for the distribution and location of regiments on clean ground, and the consequent occupation of the same camps successively by different regiments.

CHAPTER VIII.

Sanitary Administration of Hospitals.

Having dealt with the sanitary administration of camps, we shall now deal with the administration of hospitals.

Once a soldier is admitted to hospital he is placed under hygienic conditions well calculated to favour his recovery. Apart from the medical treatment and careful nursing which he receives, the hospitals camps are particularly clean, slops, excreta, and refuse are expeditiously and systematically removed, infectious material is destroyed, infected linen, bedding and clothing are disinfected, the drinking water is boiled or filtered, the milk is sterilised, and the food is protected from flies by muslin or other screens.

The successful carrying out of these details in the hospital in the field, in which a large proportion of the patients are suffering from enteric fever and dysentery, demands a well-devised administration, and there can be no doubt that in the case of the hospitals in which the responsibility and executive power devolved on the chief medical officer; such was the manner in which the administration was carried on that most of the hospital camps, though pitched on the same site for 18 months or more, were perfectly healthy and sweet, in these respects presenting a striking contrast to the condition of most standing camps occupied only for a period of three months.

Medical treatment in warfare is a much more complicated affair than medical treatment in civil life. The medical man in civil life has only to attend the patient, write a prescription or perform an operation, give instruction to the nurse as to medicine and diet, and generally direct. But

the army medical officer has to put up his hospital for 100, or may be 1,000 or more patients, equip it with bedding and every modern appliance for the sick, arrange for food supplies, for medicines and for delicacies for the sick, superintend the nurses and attendants and provide for their comforts. He has, moreover, to be the directing sanitary medical officer of the establishment, and in this capacity has to provide a water supply for the hospital and improvise methods for its purification before distribution, to provide a staff to safely dispose of the excreta and urine of the sick and healthy of the hospital camp, entailing separate distinction between infected and non-infected and their separate treatment, also to deal with the conservancy of the hospital camp and the disposal of the refuse and salliage. He has further to provide the appliances, the supervision, and the workmen for the disinfection and washing of the clothes of the patient and of the staff belonging to the hospital. Finally, he has to take an inventory of the clothes and belongings, including firearms, of every patient, and be responsible for their safe-keeping, condition, and delivery when required. This and much more has to be done by the medical staff in the army. Convoys of 50, 100, and 200 may suddenly be brought to the hospital, and arrangements have to be made for the accommodation and treatment of this influx of patients at the shortest notice. Amidst all this the treatment of patients is carefully attended to, operations are performed, records are kept, and the ordinary routine of a hospital proceeds systematically in a methodical and admirable fashion. A careful inspection of the hospitals in South Africa leads us to the conclusion that their sanitary condition and administration are admirable, and they are replete with nearly everything medical, surgical, and sanitary which medical science can suggest. Every precaution is taken to prevent the spread of infection in hospital, and to prevent the patients being infected by infected water or milk.

If there is a weak point in the administration, it is in the supply of soda-water and other mineral waters provided by the supply depôts. It is impossible to sterilise the mineral waters received at the hospital before use, and accordingly the hospital authorities are dependent on the sanitary authorities outside for the securing of a supply of mineral waters from a source above suspicion manufactured in premises in a good sanitary condition. The state of one of these factories at Bloemfontein has already been mentioned. In Pretoria many of the mineral water factories were in as bad if not worse condition, and there were few places visited where the mineral waters were prepared under entirely satisfactory conditions. Only at Naauwpoort were the arrangements good. Here a special apparatus was put up by the military, and all the water used was boiled and cooled before being supplied to the soda-water factory, which was also worked by them.

The supply of aërated waters to a large hospital is very costly under present conditions. £1,000 a month is easily expended on this item, and the profits to the contractors are very large. At Maritzburg, at a time when 1,300 beds were in use for sick and wounded, at least 3,000 bottles of mineral water were consumed daily, each bottle costing 3*d*. Less than nine months of this expenditure would have paid for the whole machinery and the establishment. In India many regiments make their own aërated waters and make a profit at ½*d*. a bottle. A large saving would be effected if to every general hospital there was supplied a soda-water and ice machine to be worked by a few trained men under supervision. It might, if required, also supply the troops in the station.

Most of the hospitals are erected on a type plan varying somewhat in the details.

Photographs are given of the Mooi River Hospital in Natal, and No. 9 Hospital at Bloemfontein. Each of them has accommodated over 1,000 patients when full.

The Mooi River Hospital was established on January 6, 1900, on an excellent site sloping away on three sides from the summit of the slightly rising ground on which it stands; within its boundary there are some 50 acres of land.

Viewing the arrangements of the hospital camp from the front there is, first of all, the buildings for wounded and sick officers consisting of verandah huts divided into comfortable rooms or wards of different sizes, but chiefly

adapted for one patient each. To these are attached the requisite out-offices.

Next is a large open space, and well away on each side of the space are tents forming the front wings of the hospital. The tents on the right wing are the nursing staff quarters, those on the left wing the camp of the medical officers.

Beyond the open space and further back than the wings, but more centrally situated, is the hospital proper. In the centre are the administrative offices which extend in a long line backwards and chiefly consist of tents. They include the general offices, Röntgen ray room, operating theatre, dispensary, chapel, recreation room, stores, &c., and kitchen. On either side of the central administrative block, and well separated from it, are the tents of the hospital, on the right side is the surgical division, on the left the medical division. The lines of tents mostly E.P. in kind are regularly and symmetrically pitched.

On the outer side of the hospital tents are the outbuildings of each division, consisting on the surgical side of bath-rooms and latrines, and on the medical side of latrines, bath-rooms, and an enclosure for the treatment of the contents of the bed-pans used by enteric fever and dysentery patients, also a laundry store for soiled linen. Behind the hospital, separated by a road and wide space, are the lines of the R.A.M.C., the corps' ablution room, kitchen and dining-room, tent-mending establishment, carpenters', tailors', and shoemakers' shops. At the rear of the enclosure is the disinfecting establishment. There is a Thresh's steam disinfector for soiled linen, bed-clothes, bedding, and soiled clothes, six Soyers' boilers, incinerator for infected excreta, destructor for camp refuse, and a collecting station for liquid refuse. Six iron slop carts were in use, the liquid refuse and excreta being removed some 3 miles from the camp and disposed of by burying.

The camps to the left and below the road is occupied by hospital dhobies, Kaffirs and Indian servants, and a small hospital for sick natives.

In the fore-front of the hospital enclosure at a short distance is the Natal Creamery, the Engineer camp, the hospital bridge and road, and the railway station and hospital siding. The water supply for the hospital is pumped up from the Mooi River into two raised tanks and from these passed through an installation of self-acting Pasteur-Chamberland filters, being first roughly filtered through charcoal and sand. The milk is sterilised and cooled before use.

Such has been the administration of the hospital, though located on the same site for over 18 months, when seen, the ground was clean and fresh, and though it contained at one time over 450 cases of enteric fever and many of dysentery received from Frere, Chiveley, Ladysmith, Modderspruit and Elandslaagte, yet not a single case of enteric fever or dysentery occurred among the medical officers, civil surgeons or nursing sisters. The excellent sanitary administration of the Mooi River Hospital is not the exception but the rule, whether the hospitals were in Natal, the Orange River Colony, the Transvaal, or Cape Colony, they all presented evidence of the most careful attention to every detail.

CHAPTER IX.

Prevention.

There are great difficulties in carrying out a sanitary régime in time of war, especially on the march, and it is requisite to recognise this fact. For instance, it can hardly be expected that men arriving in camp after a fatiguing march and perhaps at night will immediately set about filtering or boiling water and digging trenches according to regulations and that the others will wait until these are completed; or is it reasonable to suppose that on the troops leaving under sudden orders that they will carefully fill up the trenches, mark them and clean up the camp, though it is important for the regiments that follow that these things should be done. As a matter of fact, however

clear the regulations and strict the orders may be in this respect they are seldom carried out when troops are rapidly moving from place to place and more particularly is this the case with irregular troops of which there have been so many during this campaign. Again, when a regiment comes into a town, village, or encampment and is in hourly expectation of being ordered away it naturally appears to be a useless waste of energy to adopt special sanitary measures for so short a time, though as events prove afterwards the regiment remains from hour to hour and sometimes days waiting in the same place for orders. Great difficulties also arise when a number of columns or divisions converge to one place and especially when a large portion of them are poured in by train. The sudden influx of thousands of men and horses is an enormous strain on the capacity for keeping the watercourses free of pollution and the place clean. These difficulties are increased if there is an idea that the concentration is but for a few days preparatory to a general forward movement. Extremely insanitary conditions are very rapidly created at the encampments, the place of detrainment, the stations along the line and their immediate vicinity.

Again, when the troops are for some time in close touch with an enemy and there is the excitement of a battle impending, but which may not actually take place for weeks or longer and there are skirmishes and reconnoitring by the advanced patrols, it is difficult for all but the most experienced to pay the slightest attention to or put into practice the tenets of sanitation. Similarly when there is the triumph of occupying a town evacuated by the enemy there is at first a crowding and undiscipline in sanitary matters which it requires the highest organisation and care to combat the effect of.

These and similar difficulties are connected with unavoidable circumstances connected with the exigencies of warfare, and yet the conditions which arise from these unavoidable circumstances sow the seed of disease. The circumstances are, however, too often confounded with the sanitary difficulties they involve. The circumstances are certainly unavoidable, but the difficulties connected with the circumstances, formidable as they appear, may be well within the range of a practical solution and not always insurmountable.

Exceptional events cannot be taken as the measure of the ordinary conditions of a campaign and they should not be taken as the standard of the possibility or impossibility of health measures. Except during the time of an actual battle or series of battles it is not impossible to adopt suitable measures to the circumstances and by suitable organisation and appliances render the difficulties no more insurmountable than those attendant on hygienic measures on field service and in standing camps which though easily overcome by the experienced officer, more particularly so if his campaigning has been done in India, yet appear to the younger and less experienced officer to be exceptionally great and accordingly best left to the quartermaster, whose duties at all times are particularly heavy. When the regiment is split up into several units not under the immediate charge of the colonel, but each unit under a junior officer the attempt to overcome these difficulties is very small. Accustomed as the majority of officers in England are to obtain from taps a water supply already filtered, and to almost automatic arrangements for the collection, removal, and disposal of excreta of the men under their command, and of sulliage which is a necessary accompaniment of the aggregation of man, regimental officers find themselves altogether under new and perplexing conditions when everything has to be improvised and arranged for, and as a rule the duties are not rendered more easy by the soldier being undisciplined in sanitary matters in the field, and by the officer himself being untrained in sanitation. The most crude notions and practices prevail which are contrary to the simplest elements of sanitary science. It requires very little descriptive powers to portray the results. Polluted water supplies, filthy latrines covered with swarms of flies and uncovered with earth, excrement, polluted soil, manure heaps and dead horses have been the usual accompaniments of camps where large numbers of troops have been located. (See paragraph 10 of Colonel Notter's Dissenting Statement.) In the midst of these insanitary conditions there are certain to be numbers of regular troops with clean camps, but they are overwhelmed by those that are otherwise. Too much is dependent on individual effort and too little to concerted action properly controlled.

The responsiblity for this unsatisfactory condition of affairs cannot be definitely fixed on any one portion of the army, and certainly not on the medical officers of the Royal Army Medical Corps. It rests on a system which has not advanced with the times, and which permits the army to be destitute of special arrangements for the performance of the complex functions appertaining to the sanitation of an army in times of war, whether this has reference to the removal and disposal of dead horses and cattle which pollute air, soil, and water, and bring myriads of flies, or to the provision of water fit to drink, or to the safe disposal of excreta, refuse, and sewage of men and animals, or to the pollution of water, soil, food, and air, or to the prevention or checking of outbreaks of disease. There is, in fact, no properly organised machinery to systematically carry out the executive portion of the sanitary requirements of the army in warfare, nor is there any organisation to control the requisite working of the machinery. There is no specially trained and well organised executive by which the recommendations made to the commanding officer of a company or unit or brigade or division, by the medical officer, or instructions laid down in the regulations can be carried out. The regulations on paper are excellent, but the practical aspect of the question has been left out of sight, and is inadequately provided for. An organisation to be effective must be elastic, but there is no elasticity relating to the means by which the army is to be kept in a sanitary state during the time of war. There is an advisory or recommendatory agency, viz., the Medical officer, but it is not recommendations that are required, nor even orders which are seldom carried out, but action and of an immediate character. There has been abundance of advice (*vide* Appendix IX and X, instructions to officers in medical charge of units by Principal Medical Officer, army and extracts by Principal Medical Officer of 6th Division bearing on medical and sanitary administration), but advice will never effect the object in view when it is a qualified executive supervising and controlling agency that is needed. As the medical officer has only been accustomed to recommendations on sanitary matters and not to their practice which rests with others who are untrained to the manner in which the recommendations should be carried out, or to an appreciation of the urgency of their importance, the recommendations are occasionally not to the point, while it may safely be said that when they are and when accepted, which is not always the case, they are executed in the most crude and unsatisfactory manner, and not infrequently with considerable delay which deprive them of the value which they would otherwise have possessed. It is far from being recognised in the army that sanitary science is something more than untrained common sense, and that if this disease is to be prevented it is only to be done on scientific principles and on business methods.

In this campaign, moreover, in consequence of the dearth of R.A.M.C. officers there were attached to many units civil surgeons well versed in the treatment of disease but whose practical experience in sanitation was small, and whose advice in preventive medicine was not so serviceable as it might have been. They had not and would not have had any knowledge of the sanitary regulations laid down for a camp, and in consequence these matters were left to the quartermasters, some of whom were good and some indifferent in their attention to sanitary duties which, even under the best conditions, were carried out on a rule of thumb principle, and not on any scientific basis. In many instances the sole standard was to be in a fairly passable condition at the time of periodic inspection. The duties of a quartermaster are onerous and multifarious, and the more frequently his regiment moves the more busy he is. His sanitary duties form but a small part of the daily routine work. His training in no way fits him for the sanitary duties assigned to him, and the system which entrusts him with the executive sanitary work is much on the same par as that which formerly existed in civil life, when the butcher or baker were thought fit to become the sanitary inspector of a country district or town.

Theoretically and by regulation the officer commanding is responsible for the cleanliness of his camp and the health of his men, and theoretically every officer of a regiment, regular or irregular, will agree that it is a good thing to have pure water and a clean camp, but being sanitarily uneducated there is a great range of opinion as to what is potable and what is unpotable

water, and what is cleanliness and what is not, and what is practical and what is not practical. There is certainty in only one thing, viz., every recommendation that gives trouble or is not quite understood is impracticable. For instance, an irregular corps when reported for not making latrines on one occasion made the excuse that they would require dynamite for the purpose. They had selected the only rocky piece of the soil in the neighbourhood as the site for their latrines.

There is naturally a general reluctance to spare men for fatigue duties which are not in the same category as those intimately related to watching and fighting the enemy. It is different as regards men required for the supply and cooking of food. To every one it is obvious that no fighting can be done unless these are attended to, and men are specially employed for that purpose. But it is not so obvious owing to the effects being less immediate that inattention to the water supply and conservancy of the camp, and the absence of special arrangements for these are the causes of disease and reduce the strength of the regiments. Hence commanding officers will often overlook the fact of the necessity of sparing men to guard the water supply at points where it is patently liable to pollution.

Many do not take the trouble to acquaint themselves as to where the drinking water is taken from ; "somewhere over there," satisfies them, and in their opinion it is invariably excellent water, though taken from a pool or ditch which is found by inspection to receive the drainage of dead horses or cattle and human and animal excrement.

This optimistic and careless opinion is founded on a want of knowledge of the subject, and it may reasonably be asked why should it be otherwise. Not trained in hygiene, the regimental officer's mind, and rightly so, is directed to the main purpose for which his regiment is in the field, viz., dealing with the enemy, and it cannot be expected that he should, as a rule, take an interest in sanitation, a subject which is not to be learnt intuitively. The younger and keener soldier he is, the less likely is this subject to occupy his mind. This statement, however, is not of universal application, for there are many exceptions in which keen and brilliant soldiering has been associated with particular attention to sanitation, with the result that the regiments fortunate to possess these officers have enjoyed good health, and hence had the largest available force. The results are, nevertheless, dependent on the special interest manifested by the officers concerned, who are usually old campaigners, who are anxious to carry out the recommendations of their medical officers, and who have usually acquired their knowledge and experience in India, where, owing to the danger of cholera and dysentery, the importance of the sanitary conditions of the camp has forced itself on their attention. The results are apt to be marred by the insanitary condition of camps in the vicinity over which the same care is not taken.

As with the unit with its defectively-organised machinery for the purposes of sanitation, so with the brigade there is no special and well-organised controlling agency interested only in the sanitation of the camps of the brigade, and in direct touch with the Brigadier-General. Nominally, the Principal Medical Officer of the Divison is the advisory officer, but he may be 30 miles away, and even if he is with the brigade, or in the same district, he has no means of knowing what is the exact nature of the sickness in each camp or in the units of the brigade, and what is the incidence of preventable disease in each camp. From the daily returns, called the "morning states," he will be able to inform the General of the number of cases of sickness in the brigade, of which so many were from diseases such as enteric and dysentery, but from what camp or units he has no information. The returns are for the purpose of informing the General how many men he has at his disposal, and the Principal Medical Officer of the number of sick in hospital, and of the further provision of beds, transport, &c., likely to be necessary, the returns being an index of the general health of the brigade as a whole. The advice on this indefinite information can only be of a general character, and may be accepted or not. The responsibility of the Principal Medical Officer ceases after his advice is given. If accepted, there is no special agency by which he can ascertain whether it is being carried out promptly and in the manner prescribed. In sanitary matters outside the hospitals he has no administrative powers. His administrative work lies wholly in another direction, viz., the

transport of the sick and wounded and the provision for their medical attendance and nursing. Similarly, the same remarks apply to the Principal Medical Officer on the Lines of Communications, and to the Principal Medical Officer of the Army at Headquarters. The weekly returns which are forwarded to the latter officer, and to the Director-General in London, are practically compilations from the daily returns, and convey only a general idea of the health of the army as a whole. They may be excellent returns for the purposes for which they are intended, but they are not returns useful for sanitary administration and control.

With then no special but with a defective and untrained organisation to look after the water supply and sanitation of the camp, and which becomes disorganised under the slightest difficulties which must arise in warfare ; with also an absence of any specially trained controlling and administrative agency for brigades, divisions, and the whole army, and with no camp notification of zymotic disease to headquarters, outbreaks of disease cannot be prevented or checked, or minimised in the army any more than they could be under similar conditions in civil life. (See paragraph 11 of Colonel Notter's Dissenting Statement.)

The knell to the development of sanitary science and sanitary administration in the army as a preventative against disease, and applicable to the troops, was given by the late Commander-in-Chief. On page 110, "Wolseley's Pocket Book," 1886 edition, is to be found the following :—

"Sanitary officer is the creation of recent years, and as a general rule he is a very useless functionary. In the numerous campaigns, when I have served with a sanitary officer, I can conscientiously state I have never known him make any useful suggestions, whereas I have known him make many silly ones. It is not his fault, for with an army moving it is impossible to drain a town, as I have known suggested, or carry out any great sanitary measure. There is not time for any great sanitary works, and for the ordinary cleanliness of temporary camps or bivouacks the Principal Medical Officer with each division can do all that is necessary. In future, so long as this fad continues, my recommendation is to leave him at the base, where he may find some useful occupation as a member of the Sanitary Board, which I think should have charge of all sanitary arrangements at the base."

Lord Wolseley recognised the uselessness of the sanitary officer not specially trained, whose opinion was likely to be of no greater value than the ordinary medical officer, and who was possibly selected as sanitary officer because he was the only officer that could be spared ; and further it might be added under the present régime with no administrative powers ; but he did not recognise that these conditions could be remedied and would generally have improved, and so the sanitary officer was abolished and sanitation under war conditions viewed more or less as a fad. Even the Sanitary Board that Lord Wolseley commends at the base seems to have died of inanition, and the army was sanitarily left to take care of itself except so far as could be managed by the different principal medical officers in making suggestions. (See paragraph 12 of Colonel Notter's Dissenting Statement.) Sanitation resolved itself under these circumstances into a few set recommendations, such as boil the water, filter the water, and burn or bury the carcases. The answers to which were reasonable and conclusive ; viz., there is no fuel for boiling nor storage to cool afterwards, the filters will not work with muddy or slimy water, they easily break and the men missuse them, and the carcases cannot be made to burn without kerosene, and if they are to be buried there are no men to spare to do it. Even when the recommendations were of a more easy kind to carry out great delay was the usual feature, for instance when enteric fever broke out in the army on the Modder River after the battle of Maggersfontein, and new wells were recommended by the Principal Medical Officer to be sunk because those used were polluted and the river water was contaminated, the wells were only completed shortly before the army left in February. If there had been a sanitary medical officer and sanitary engineer attached to Lord Methuen's army in the first instance these wells and a fit water supply would have been given to Lord Methuen's army in a few days after settling down in the encampment. They would have been carried out as necessary works, not to check an epidemic if possible, but to prevent one.

Sanitation of the camps as a whole can never be a success under the

conditions referred to. Wherever there has been a marked success it has been due to individuals and not to a system. Sanitary science as an organised force has not, except in the hospitals, played any part in the campaign, not because it was impossible or impracticable, but because there has hitherto been no proper provision in the army for sanitary administration during the time of war, and thus it happens that an army in one of the finest climates and most open countries in the world, is not only exposed to the seasonable diseases endemic among the civil population, but carries these diseases about with it from place to place, suffering in proportion to the negligence to sanitary laws. If the same army had operated in Bengal in the cholera season it would have run a very great risk of the larger portion of it being destroyed by cholera.

With a trained sanitary service whose duty it would have been to concern itself with the health of the army under every condition, it would have been known that enteric fever, dysentery, and diarrhœa were diseases very prevalent in South Africa, and special provision could have been made for the protection of the invading army.

The remedy for this state of affairs lies in a recognition that there are limitations to the work that a fighting man can perform in time of war. If he is to shoot well, do outpost duty, attend to his horse, and perform all the other duties that belong to him as a soldier, as well as dig trenches and get water, it is hardly to be expected that he can also keep these trenches always covered, the drinking water always boiled, and the refuse, offal, manure, and dead horses and cattle removed and disposed of in the safest places. It sounds well that the soldier should do everything for himself, but practically it does not work out a success.

While insisting that the soldier shall conform to the ordinary and existing regulations of the army with regard to the cleanliness of his camp, and more complicated essentials of sanitation ought to be recognised as of a supplementary nature outside his ordinary duties, and as such should be performed by special agencies, which as they do not exist at present must be provided. This entails no very great or radical change in the present arrangements, but some additions which will fit in with those which now exist.

In a regiment the commanding officer must necessarily be the supreme authority and be responsible for the health of his men, but his duties in this respect and those of his adjutant would be rendered easier and more successful if to the existing arrangements were added :—

1. A camp quartermaster-sergeant belonging to the R.A.M.C.
2. A certain number of or a pioneer-sergeant, specially trained Mehters and sweepers for latrine work and the disposal of dead animals, &c.
3. A special water section.

(1) A camp quartermaster-sergeant should be appointed for executive sanitary duties connected with the regiment in order that all orders and regulations shall be promptly and properly carried out under trained and efficient supervision. He would be to the regiment what the sanitary inspector is to the civil population, and he should be as highly trained. Once appointed to a regiment for sanitary work it is essential that he could not be removed to hospital or other duties because of stress in other departments, but that once placed in the sanitary department he should be always in it unless found unfit. He would be responsible to the commanding officer for the cleanliness of the camp, the purification and storage of the water supply and the quality of the food, and would be directly or indirectly under the orders of the medical officer of the regiment. He would supervise the work of the sanitary police and report any infringement of sanitary orders. (See paragraph 13 of Colonel Notter's Dissenting Statement.)

(2) No trench system of latrines will ever be safe particularly in warm climates and in countries with dust storms and strong winds unless a man is always at each latrine to cover the excreta immediately after the latrine has been used. No white man or soldier will do this, but Mehters, the sweeper caste in India, and low class Indians will perform the work without any objection. Every Indian regiment has its own proportion of Jemadars, sweepers, and water carriers. In cold climates the immediate covering of the ordure may not be so absolutely necessary, but in the tropics where

flies abound the question becomes one of urgent need and in such cases Mehters can always be recruited from India. If a few were attached to each regiment in the time of war the latrines could always be kept covered with earth mixed with lime or with earth alone, and the risk of disease caused by uncovered latrines be avoided. The danger from a trench is not so much in its position unless it is near a well or stream, but from the condition in which it is kept. If the trench is uncovered and ill-kept, flies will swarm to it and from thence to the tents and kitchen and stores, alighting on food and drink and contaminating them with excreta. This can be avoided by properly constructed and protected trenches carefully covered when used. Even if there are flies from other sources they will not be contaminating food and drink with excreta possibly mixed with incipient dysentery and enteric fever stools. Similarly the urine tub and urine trenches have to be carefully looked after and chloride of lime or corrosive sublimate used in them to prevent flies and to destroy enteric bacilli in the urine of soldiers who may be walking about with the infection of enteric fever on them. (See paragraph 14 of Colonel Notter's Dissenting Statement.) In more permanent camps, in which pails instead of trenches are likely to be used, the same necessity arises for the covering over of the excreta immediately after use. The Mehter not only covers with earth as required but is available to remove the pail when necessary and have its contents properly disposed of.

Similarly, in regard to the disposal of refuse, offal, and dead animals, native labourers under supervision are the cheapest and the best. They are already employed by the Royal Engineers, by the army corps, and by regiments for transport.

(3) With an efficient system for the disposal of waste it is necessary to provide an agency to secure at all times a pure water supply. This can only be effected by the provision of a special water section whose sole duties would be to attend to the water carts and to the preparation, storage and distribution of pure water. In this connection it has to be recognised that polluted water is one of the main sources of enteric fever and dysentery, and as such has to be specially guarded against. Many instances can be given of water polluted with sewage doing no harm, due on some occasions to the season of the year, on others to the absence of any specific pollution, and on others to the insusceptibility of those who drink the water, but these facts have to be borne in mind, viz., that the army mainly consists of young men at an age highly susceptible to enteric fever, that war is carried on during the enteric fever and dysentery season as well as the healthy season, and that it is impossible in the field to discriminate between water polluted with healthy sewage and that polluted with enteric fever and dysentery germs. Accordingly the drinking of water contaminated or liable to be contaminated with sewage involves a considerable risk which cannot be avoided in any other way than by careful selection of the source of supply, guarding that supply from pollution, sterilisation of the water either by filtration, chemical reagents, or by heat. It is not practicable or safe for the requisite purification to be left to the discretion or to the individual efforts of the soldier. It must be done for him, and for that purpose a water section with appliances is required.

In some regiments there already exists the nucleus of a water section created by the thoughtfulness of the commanding officers, and the idea which has already taken practical shape merely requires development and extension. To every regiment of 1,100 men three men from each company were deputed to attend to the water supply, to filter it and arrange a sufficient supply. At the beginning of each march the men's water bottles were filled with tea, and any water they might require for drinking on the march had to be taken from the water cart. On arrival in camp, and the source of supply having been determined upon, the water was brought to the camp in water carts, and as the filters were always taken out of the transport wagons at once, they were in readiness to filter the water. As long as the regiment was stationed in camp the filtration was continued and it was found that two or three men, according to the muddiness or clearness of the water, were sufficient to give a most ample supply to every 100 men. When the water was muddy it was necessary to subject it first of all to rough filtration. The water supply staff thus organised was relieved of all other duties. They were, however, available for fighting when the enemy were near. By this system the commanding officer was enabled to secure under every condition a pure water, and the men

engaged in the work being relieved of their other duties took an interest in it.

Special importance attaches to the fact that some officers were able throughout arduous marches to make use of filters at all the camping stations and to supply the men under their command with filtered water. This fact is particularly important in view of the very prevalent opinion expressed by officers and not infrequently by medical officers of the Army that it is impossible to arrange for filtering water on the march or even in temporary camps. It is stated that the filters get destroyed, often purposely by the men, or are lost, or left behind, or thrown away because they give much more trouble than is commensurate with the results. Some even go so far as to express views that it is a matter of small moment as to what kind of water is drunk. With these views pretty general, it is not surprising to find that insufficient attention has been directed during the campaign to the source of the water supply and its protection from contamination by excreta or sulliage or to any methods of purification by boiling or filtration. The supply, purification by boiling or filtration, and storage of purified water for the soldier simply resolved themselves into a matter of organisation. At present the general idea is that the soldier must shift for himself and look after himself in these matters, which theoretically may be good but practically is fatal.

It frequently happens that one man is given charge of the filters, but he has usually other duties to perform; not infrequently the filters are placed in charge of the cook, or one man is given the care and cleaning of the filters and each man in the company when he wants a drink is expected to filter the water himself. Both methods are fatal to any system of filtration, and the obtaining of water under such arrangements or absence of arrangements is exceedingly difficult, and, accordingly, it is soon given up as impracticable. The supply of pure water will never be a success and be nothing but a myth until there is in every regiment a water supply and filtration staff, whose sole duty is to supply sterilised or filtered water to the regiment. With such a staff or section a sufficient quantity of pure water would constantly be available, and it would be as easy for the soldier to obtain filtered or boiled water from the camp as it now is for him to obtain unfiltered water. In fact it would be easier as there would always be an abundant supply, whereas under the present chaotic arrangements, with no one responsible, the carts in camp are frequently empty, and the soldier has to go elsewhere for a drink of water.

CONTINUATION OF HEALTH ORGANISATION.

The suggested slight changes in the units do not, however, provide the machinery for the sanitary administration and control of the brigade division, army corps, and army as a whole. If one regiment of a brigade carries out its health arrangements badly it is likely to endanger the whole brigade, and there are health matters outside the jurisdiction of the regimental officer which properly come under the administration and control of a higher authority. This can only be effected by the formation of a special army health or sanitary service, whose sole duty is to deal with all matters relating to the sanitation of camps and the health of the troops as distinguished from those now appertaining to the transports and treatment of the sick and wounded. All medical officers of the Army are taught hygiene at Netley as a part of their preparatory course before obtaining commissions, but it is only a small percentage of their number who display an aptitude for this subject or who are capable of so assimilating the facts put before them as to become efficient sanitary officers. Because a man goes through a hygienic course and passes an examination in the subject it does not necessarily follow that he is a competent sanitary officer. This fact is patent to all who are brought into contact with men who have taken public health diplomas from civil training boards. But comparatively few of these diplomates make good medical officers of health.

For the needs of the Army it is desirable that subsequent to their obtaining a commission those officers of the R.A.M.C. who show an aptitude

for and express a desire to take up sanitary science should undergo an extended course of instruction (theoretical and practical) followed by an examination, the result of which should be taken into account for selecting men as sanitary officers. By such means a special health service could be created, for it cannot be said that one already exists at present. Theoretically, and according to regulations, the regimental medical officer, the senior medical officer of the brigade, the Principal Medical Officer of the division, and the Principal Medical Officer of the Army are sanitary officers with their other duties. But when the duties they perform are analysed, preventive measures are found to form a very small part, and as a matter of fact can at the best be only spasmodic and far from continuous. Their chief work lies in the organisation necessary for the transport of sick and wounded to hospitals, which is altogether distinct and apart from the organisation and duties required for a health corps. Each organisation deals with disease from a different standpoint. This fact was recognised long ago in civil life and led to the formation of a health service.

The organisation for the transport of the sick and the wounded is concerned with persons, that for the health of the troops with the physical conditions in warfare; camps and not hospitals, localities and not persons are the sanitary aspects of a campaign. It is necessary to make this clear, because the machinery and methods of the one differ from those of the other. In the one case the interest centres in the patient, his treatment in hospital, his convalescence, and his return to duty; on the other the interest is in the camp, its hygiene, the health of the soldier, and the prevention of disease.

On the other hand, the organisation for the treatment of the sick and wounded involves an administration for the provision of transport, hospital trains, mobile and stationary hospitals, nurses, orderlies, doctors, equipment, and supplies. It further involves arrangements for the clerical work and compilation of statistics, medical and general, which belong to so vast a machinery rendered more vast and complex if, as in the present war, the army is increased to more than four times the original estimate.

On the other hand an organisation for the prevention of disease provides in each brigade, division, or district for a daily collection and scrutiny of vital statistics, especially of the zymotic group, not in regard to hospitals but in regard to camps and in relation to the incidence of disease on the different units in order to localise the sickness, it arranges for the tabulation of the statistics in a weekly form to be forwarded to headquarters so that the health condition of the camps may be judged from these indices and not from general statements, it arranges also for investigation into the prevalence of any infectious disease in any special camp or unit and for the prompt adoption of measures to remove the particular causes of sickness. It is also responsible for the appliances and equipment needed to obtain a pure water supply and for securing the best health conditions possible to the troops, not when disease breaks out but on every occasion. The two organisations may touch with advantage at one point, viz., at the regiment or unit. The regimental medical officer can be made use of both for the sanitation and medical care of the regiment, provided the defects of the present campaign are avoided viz., the rarity of being long attached to a regiment, the frequent changes, the appointment of civil surgeons with no training in sanitary work, the absence of the assistance of a trained executive officer and staff to carry out recommendations, and the want of any definite knowledge as to the true state of the health of the unit under the regimental medical officer because of the non-receipt of any official information from the hospital of the nature of the disease of the soldier he has sent there for treatment.

The combination of duties if to be effectively performed is however limited to the regiment and the regimental medical officer. Beyond the regiment the functions rapidly diverge and become more complex as larger and more numerous bodies of men have to be dealt with, rendering it impossible for the control and administration of both organisations to be centred in or carried out satisfactorily by the same agency, and consequently it is absolutely essential to be undertaken by a special health service or sanitary cadre.

By decentralising the health arrangements of the regiments and units

and centralising control, a thorough grasp of the health conditions of an army in the field is feasible, and with that grasp the administration is practicable.

The suggested Army Health Corps requires to be quite a distinct and separate corps in order that its members may be debarred from being recalled to other duties, as any liability to recall would destroy its existence and usefulness. There should be no possibility of any R.A.M.C. officer in the health corps being given other duties because there happens to be pressure on the medical side and there is a difficulty in meeting the demands of medical transport or hospital arrangements. An army health corps or health service would consist of officers of the R.A.M.C. and staff specially trained in preventive medicine, and of Royal Engineers and staff specially trained in sanitary constructive work or if it is thought advisable that this selected section of the Royal Engineers, specially trained for sanitary construction should not form an integral part of the health service the section should be associated with it to work in consort with the health officers. The need of this expert training both for officers of the R.A.M.C. and the Royal Engineers is patent in many of the works undertaken, and accounts not infrequently for failure. For instance it was decided to deal with the slop water from a certain standing camp by treating it bacteriologically. The works considered to be necessary were constructed and the filtering material employed indicated that neither the adviser of the process nor the constructor of the works had the slightest notion of a bacteriological filter. The cause of failure would be assigned to anything but ignorance. (See paragraphs 15 and 16, Colonel Notter's Dissenting Statement.)

To form a special health service under existing conditions it is only necessary to follow the lines pursued in other services.

In the Indian Civil Service a member after a certain number of years can choose whether he will enter the executive or judicial side of the service. Once the choice is made the duties are entirely separate and the careers distinct.

Similarly in the Navy the duties are specialised.

In the same way it would be well if the R.A.M.C. consisted of two branches as follows :—

(*a*) The medical branch.
(*b*) The health branch.

The medical branch would contain the regimental medical officers and the medical men engaged in transport and treatment of the sick, the Principal Medical Officer as now existing, but with no sanitary responsibilities, and the Director-General in London.

The health branch, on the other hand, would contain the health officers, who would be staff officers of the Generals in the field and districts, and whose promotion would be to the grade of the Chief of the Health Service at the War Office, London, just as the highest promotion in the sanitary section of the Royal Engineers would be that of Sanitary Engineer-in-Chief.

For an army in the field there should be a sanitary or health officer certainly with each brigade, and in touch with the chief sanitary officer at headquarters.

A health officer and trained staff for each brigade, each division, each army corps, and for the headquarters of the army, together with a sanitary engineer for each division, as well as a health officer and sanitary engineer for the lines of communication, would constitute the Army Health Service. It is evident that the health service if organised on this basis would not be a large one, at the same time under the respective generals it would be sufficiently large and powerful to place the Army under the best health conditions that sanitary science and the circumstances of warfare would permit. It is essential that the health officer should be a staff officer of the General to bring him in close touch with that officer's movements and wishes, to permit him to make the necessary preparations in time, to avoid delays, to enable him to issue orders and to give him the requisite power. Power should be given to spend money on water supplies and on the proper and efficient disposal of refuse, slop-water, excreta, dead animals, &c. Money is spent on these matters now, but as a rule after much delay, and when disease has already broken out in the camp. Moreover it is often spent without any corresponding benefit, because, being carried out without any trained super-

vision and control, other insanitary conditions are produced which in due time induce their evil effects. It has happened over and over again that water supplies have been polluted and rendered dangerous by burying animals and disposing of refuse close to springs and streamlets.

Once an officer of the R.A.M.C. selects the health branch of the service it is necessary that he should undergo special training to fit him for his duties, after which he should be placed in positions which will permit of his acquiring practical experience in the exercise of his speciality. Beginning with smaller appointments in the home districts of the army in the United Kingdom, which can be followed by more important health appointments abroad, in India, South Africa, and elsewhere, he will gradually acquire that experience which will make of him a specialist in his department, and a useful, practical and experienced sanitarian.

With the special health service organised on the basis suggested, the health difficulties connected with warfare will receive proper attention and consideration, and there can be little doubt that when trained health officers and sanitary engineers are engaged in devising methods to overcome these difficulties and adopt preventive measures to the exigencies of warfare success will ensue. It will be taken for granted that wherever an army goes it will be exposed to the diseases prevalent in that country, that the quality of the water drunk by the troops plays a very important part in their state of health, and that the conditions of warfare bringing in their train arduous duties and fatigue under all weathers, loss of sleep, irregular meals, sometimes scanty in quantity, at other times in excess, and the massing together of young men under more or less unusual and abnormal circumstances, with its concomitant effects render that army peculiarly susceptible to disease, and accordingly all the more in need of being placed under the best hygienic conditions possible.

To be in a position to obtain those best conditions, the army health or sanitary bureau in London, besides being the centre of information on statistics and all health matters relating to the Imperial and Colonial armies, at home and abroad, as well as of foreign armies, will need to be the depository of information collected and recorded concerning the endemic diseases in different countries, the conditions that give rise to them, and their mode of prevention, as also concerning the topography and geology of those countries, more especially in relation to their water supplies and the quantity of fuel obtainable. Water-boring drills and equipment, filters, water carts, sterilisers, disinfectants, disinfectors, kinds of clothing, diet, the cremation or disposal of dead animals will, among other subjects, engage the attention of the officers in this bureau with the view that an army leaving the shores of England shall be fully and properly equipped to safeguard itself against the ravages of preventable diseases.

On the lines of communication, the stations or centres through which the troops are passing would be immediately provided with the equipment of establishments necessary to keep the localities in a state of cleanliness and the troops in a state of health. It would be the business of the health or sanitary officer to organise the necessary staff to secure at each place a sufficient supply of water for men and animals, and to obtain the purification of that which is for the men; to provide adequate establishments for the construction, cleanly maintenance, and disinfection of latrines, the proper disposal of their contents, the removal of nuisances, and the efficient removal and disposal of refuse, litter, offal, dead animals, &c., also to arrange for the sanitary policing of the place to prevent nuisances being created and to guard contaminated as well as pure water supplies, in order that in the one case the men shall be prevented from drinking dangerous water, and in the other case fouling the pure supply. Special care would be taken that the troops passing through did not successively occupy the same camps, and certainly not until the previously occupied camps had been thoroughly disinfected and cleaned. Similar precautions would be taken in localities at which troops were mobilising and concentrating preparatory to any special movement. The health officer as a staff officer of the General, being cognisant of the proposed movements, would be able to visit and arrange health matters before the arrival of the troops, the executive work being carried out by the camp quartermasters.

Troops occupying a town or its environments would be placed at once under sanitary control; the principal health officer of the division or the senior health officer of the division, if there is more than one division, immediately assuming for the time being the position of chief health officer for the town and environments, with each brigade health officer as health officer of the district in which his brigade is located. This would give the army control over the sanitary condition of the water supplies, milk supplies, aërated water supplies, and general sanitation without disturbing the ordinary executive routine of the civil sanitary authorities, if any, further than adding what was necessary.

A more effective and prompt control of sanitary matters relating both to the army and civil population would have been obtained if there had been an army health service in Pretoria, than was accomplished by the health officer specially appointed in August by the Commander-in-Chief. In the first place it would have begun its work in June when Pretoria was first occupied, it would have had control over the location of camps, the disposal of dead carcases, and many other things which contributed to the ill-health of the Pretorian army.

Large standing camps and districts in which camps are located would equally come under supervision and control, while in the advance of the main army the health officer would proceed with the staff officer whose duty it is to select the various camps. After battles the health service would see that the burial of the dead was not conducted so as to be a danger to the living.

The chief health officer with the army would be responsible for the proper working of the health organisation as a whole, for the collection and tabulation of the health statistics of the camps, and for any special inquiry into prevalence of or nature of disease which he may think that these statistics call for, his scientific assistants being trained pathologists and bacteriologists. (See paragraphs 15 and 18, Colonel Notter's Dissenting Statement.)

Mr. Bernard Ritso, A.M.I.C.E., Inspector of Boring to the Cape Government, has recently, at the request of the officer commanding the Royal Engineers, Cape Town, furnished him with notes on the formation of an Imperial Boring Department, pointing out that in the formation of such a department a knowledge of the geological formation of the country to be prospected for water and of the kind of machinery and appliances suitable for putting down boreholes are the first conditions of success, and that skill in the design or selection of machinery suitable for the particular work is second only in importance to the scientific and practical knowledge necessary in making a geological survey of the ground and in selecting sites. He deals with military water boring units, water supply for an army, column sections, depôt sections, and lines of communication and base; also the training of officers as boring engineers, the training of non-commissioned officers and men; the organisation necessary to provide the requisite staff and machinery for boring water on campaigns in foreign countries which includes headquarters in London and a division into a "geological branch" to collect data relating to geology and subterranean waters of all countries where campaigns are possible; a "mechanical branch" to design and construct boring plants especially suitable for military purposes, set diamond crowns and maintain stores and an "administrative branch" for clerical and financial work. (See paragraph 17 of Colonel Notter's Dissenting Statement.)

The advocacy of an Imperial Military Boring Department like the advocacy of a Royal Water Corps by Dr. Leigh Canney only proves that in the opinion of those who have given the subject a careful consideration that something requires to be done in order to provide a pure water supply for the troops on a commensurate scale. The problem of the prevention of dysentery and enteric fever will not, however, be solved by the adoption of either of these suggestions by themselves. The real solution is an organised health service in which the water boring establishments and water corps or staffs shall take their proper place in the machinery of this service.

To recapitulate, the changes suggested are as follows:—

1. *For the Units or Regiments* it is recommended—

(*a*) That a camp quartermaster, trained in sanitary work, should be specially appointed as the executive officer to closely supervise and carry

out the necessary duties to be performed by the water section and pioneer section of the regiment or unit. These are two sections which should be developed more than at present, and specially maintained as the sanitary service of the regiment.

(*b*) That in warm countries, and in places liable to dust storms and pestered with flies, a mehter establishment should be attached to each regiment or unit.

(*c*) That the medical officer of the regiment would, as at present, be the technical adviser on sanitary matters to the officer commanding, and be empowered with the general supervision and control of the work done by the camp quartermaster. He would transmit weekly to the brigade health officer a tabular statement of zymotic sickness occurring in his camp or camps, having officially received the diagnosis of the disease from the hospital into which the soldier was admitted. To this statement would be also attached a note on the water supply and method of purification, as well as information on other health matters that might from time to time be required by the brigade. He would keep a copy of both statements for regimental reference, and for the information of the commanding officer.

2. *For the Larger Administration and Control of Health Matters in the Army* it is recommended—

(*a*) That a separate health or sanitary service be created which shall consist of officers of the R.A.M.C. who have undergone a special training, theoretical and practical, in military preventive medicine and public health work; and of a few selected officers of the Royal Engineers specially trained in regard to sanitary construction and appliances, or if it is deemed advisable that this selected section of sanitary engineers who have been especially trained shall not form a material part of the health or sanitary service, the section should be associated with it to work in consort with the health officers.

(*b*) That for an army in the field there shall be a health officer or sanitary officer for the lines of communication, responsible for the health arrangements provided for the troops at the different stations.

(*c*) That with each brigade, and as staff officer to the Brigadier-General, should be a sanitary officer, and at headquarters, in a similar position, should be a chief sanitary or health officer and a sanitary engineer.

(*d*) That the sanitary officer shall, through and with the approval and sanction of the General, issue the requisite orders on all matters relating to the health of the army under the General, and shall take the necessary measures to prevent, check, and control an epidemic.

(*e*) That the sanitary engineer shall possess the power of expending the necessary money on authorised projects, and shall have under his control and be responsible for all the larger sanitary works that may be required, which would be the supply of water by drill, boring, or other available methods, its central purification, if necessary, and its distribution in camps.

(*f*) That the Sanitary Bureau of the War Office in London shall consist of—

(1) A scientific branch.
(2) A general health administrative branch.
(3) A sanitary equipment branch.

In conclusion, it will be observed that no mention is made in this report on the influence of inoculation as a preventive measure against enteric fever. The reason for this is that it was impossible to collect in South Africa all the statistics on the subject, and the fragmentary data collected by us would be valueless for estimating the preventive power of the inoculations. When the

admission and discharge books are available, and it is possible to collaborate all the statistics, Professor Wright, whose work in connection with this is of the highest importance and value, will doubtless be able to furnish the requisite information and conclusions.

COST OF ENTERIC FEVER.

The cost of enteric fever in the South African campaign has been very great, and viewed merely from a financial point of view the taking of the necessary preventive measures would effect a large saving. In order to make this clear it is only necessary to calculate the cost at the lowest figure.

Assuming that the cheapest trained infantry soldier costs £40 by the time he arrives at his destination in South Africa, the monetary loss to the Government will be :—

1. If he dies from enteric fever and has to be replaced by a trained soldier :—

——	Amount.
	£ s.
Cost of man	40 0
Cost of successor	40 0
Hospital..	5 0
Burial	1 15
Pay in hospital..	0 15
Per man	87 0

2. If he is attacked with enteric fever but recovers and convalesces in South Africa. he will be unfitted to join his regiment for at least four months :—

——	Amount.
	£ s.
Cost of man	40 0
Hospital..	10 0
Pay, four months	6 0
Convalescent messing	0 15
Travelling, &c...	0 5
Per man	57 0

3. If he is attacked with enteric fever but recovers and is invalided home and has to be replaced by another man :—

——	Amount.
	£ s.
Cost of man	40 0
Successor	40 0
Passage home	10 0
150 days' pay	7 10
Hospital..	10 0
Travels	0 10
Per man	108 0

During the two years of the war there have been at least 31,118 cases of enteric fever which is nearly the strength of a full army corps. Of these 31,118 patients, 6,172 have died, 15,120 have been invalided home, and 9,726 have convalesced in South Africa.

At the above rates the cost of the 31,118 men would be :—

		Amount.
		£
1. 6,172 × 87	.. .. =	536,964
2. 9,726 × 57	.. .. =	554,382
3. 15,120 × 108	.. .. =	1,632,960
	Total	2,724,306

To this has to be added the cost of extra hospital staff, equipment of hospitals and transport which would bring the cost to at least £3,500,000, if not £4,000,000.

This calculation only refers to enteric fever and does not include dysentery. The basis is also on the cheapest soldier available. An artillery-man is more costly still, and a yeoman, volunteer, and colonial more costly than a cavalry man.

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D.P.H.

November 29, 1901.

APPENDICES.

LIST OF CONTENTS IN APPENDIX.

APPENDIX I.

The following table is extracted from the reports on the public health of Cape Colony for the year 1894 :—

District.	Infectious Diseases which are stated to have occurred during the Year.
Aberdeen	*Typhoid fever*, diarrhœa, diphtheria, scarlatina, measles, chicken-pox, mumps, influenza
Albany	*Typhoid*, *dysentery*, diarrhœa, diphtheria, scarlatina, whooping-cough, influenza, small-pox
Albert	*Typhoid*, typho-malarial fever, scarlatina, measles, rötheln, whooping-cough, chicken-pox, mumps, influenza
Moltena	*Typhoid*, *dysentery* and diarrhœa, diphtheria, scarlatina, rötheln, influenza, small-pox
Venterstad	*Dysentery* and diarrhœa, diphtheria, scarlatina, measles, chicken-pox, mumps, influenza
Alexandria	Influenza
Aliwal, North	*Typhoid*, *dysentery*, diarrhœa, diphtheria, scarlatina, measles, rötheln, whooping-cough, chicken-pox
Jamestown	*Typhoid*, *dysentery* and diarrhœa, diphtheria, measles, whooping-cough, chicken-pox, influenza
Lady Grey	Diphtheria, scarlatina, measles, whooping-cough, influenza
Barkly East	*Typhoid*, typho-malarial fever, scarlatina, measles, whooping-cough
Barkly West	Scarlatina
Klipdam	*Typhoid*, typho-malarial fever, *dysentery*, diarrhœa, diphtheria, scarlatina, measles, chicken-pox, mumps, influenza
Bathurst	Small-pox
Beaufort West	*Typhoid*-diphtheria, scarlatina, chicken-pox, small-pox
Bedford	*Typhoid*, dysentery and diarrhœa, diphtheria, croup, measles, rötheln, whooping-cough
Bredasdorp	Typho-malarial fever, measles
Britstown	*Typhoid*, *dysentery* and diarrhœa, diphtheria, measles, chicken-pox, influenza, small-pox
Caledon	*Typhoid*, *dysentery* and diarrhœa, diphtheria, measles, mumps, influenza
Calvinia	*Typhoid*, *dysentery* and diarrhœa, scarlatina, measles, mumps
Cape	*Typhoid*, *dysentery* and diarrhœa, diphtheria, scarlatina, measles, influenza, small-pox
Durbanville	*Typhoid*, diphtheria, croup
Woodstock and Maitland ..	*Typhoid*, typho-malarial fever, diphtheria, scarlatina, measles, chicken-pox, influenza
Carnarvon	*Typhoid*, diphtheria, whooping-cough, influenza
Cathcart	*Typhoid*, *dysentery* and diarrhœa, diphtheria, scarlatina, whooping-cough, chicken-pox, influenza
Ceres	Diphtheria, scarlatina, chicken-pox, influenza
Clanwilliam	*Typhoid*
Colesberg	*Typhoid*, röthein, chicken-pox
Cradock	*Typhoid*, scarlatina, rötheln, small-pox
Maraisburg	*Dysentery* and diarrhœa, diphtheria, scarlatina, measles, whooping-cough, mumps, influenza, small-pox
East London	*Dysentery* and diarrhœa, diphtheria, scarlatina, measles, whooping-cough, influenza, small-pox
Fort Beaufort	*Dysentery* and diarrhœa, measles, whooping-cough, influenza, small-pox
Adelaide	Diphtheria, measles, whooping-cough, small-pox
Fraserburg	*Typhoid*, diphtheria, influenza
Williston	*Typhoid*, influenza
George	*Typhoid*, influenza
Glen Grey	*Typhoid*, *dysentery* and diarrhœa, scarlatina, whooping-cough, influenza, small-pox
Graaff Reinet	*Typhoid*, typho-malarial fever, *dysentery*, and diarrhœa, and diphtheria, scarlatina, measles, chicken-pox, influenza, small-pox
New Bethesda	.. ..
Hanover	*Dysentery* and diarrhœa, diphtheria, influenza, scarlatina, small-pox
Hay	Typho-malarial fever, diphtheria, mumps, influenza
Herbert	*Typhoid*, measles
Herschel	.. ..

APPENDIX I.—*continued.*

District.	Infectious Diseases which are stated to have occurred during the Year.
Hope Town	*Typhoid*, typho-malarial fever, measles, rötheln, whooping-cough, influenza
Humansdorp	Scarlatina, small-pox
Jamsenville	*Typhoid*, rötheln, mumps, influenza
Kenhardt	.. ..
Kimberley	*Typhoid*, diphtheria
King William's Town ..	*Typhoid*, *dysentery* and diarrhœa, diphtheria, croup, scarlatina, whooping-cough, chicken-pox, influenza
Keiskama Hoek	*Typhoid*, typho-malarial fever, *dysentery* and diarrhœa, whooping-cough, mumps, influenza, small-pox
Knysna	Typho-malarial fever, chicken-pox, influenza
Komgha	Measles, whooping-cough, chicken-pox, small-pox
Ladismith	*Typhoid*, diphtheria, measles, chicken-pox, influenza
Malmesbury	*Typhoid*, *dysentery* and diarrhœa, diphtheria, scarlatina, influenza
Middelburg	*Typhoid*, *dysentery* and diarrhœa, diphtheria, rötheln, small-pox
Mossel Bay	*Typhoid*, *dysentery* and diarrhœa, influenza
Murraysburg	*Typhoid*, *dysentery* and diarrhœa, diphtheria, croup, scarlatina, influenza
Namaqualand	*Typhoid*, *dysentery* and diarrhœa, chicken-pox, influenza
Oudtshoorn	*Typhoid*, typho-malarial fever, *dysentery* and diarrhœa, diphtheria, croup, scarlatina, measles, rötheln, chicken-pox, mumps, influenza
Calitzdorp	*Typhoid*, typho-malarial fever, diphtheria, scarlatina, measles, chicken-pox, influenza
Paarl	*Typhoid*, *dysentery* and diarrhœa, diphtheria, croup, scarlatina rötheln, chicken-pox, mumps, influenza
Peddie	Scarlatina, measles, small-pox
Philipstown	*Dysentery* and diarrhœa, measles, rötheln, chicken-pox, influenza
Piquetberg	.. ..
Port Elizabeth	*Typhoid*, small-pox
Porth Nolloth	Small-pox
Prieska	Typho-malarial fever, *dysentery*, diarrhœa, measles
Prince Albert	*Typhoid*, typho-malarial fever, *dysentery*, diarrhœa, diphtheria, croup, scarlatina, measles, chicken-pox, mumps, influenza
Queen's Town	Diphtheria, scarlatina, measles, small-pox
Richmond	*Typhoid*, *dysentery* and diarrhœa, diphtheria, scarlatina, rötheln
Riversdale	*Typhoid*, diphtheria, influenza
Robertson	*Typhoid*, diphtheria, croup, measles
Simon's Town	*Typhoid*, *dysentery* and diarrhœa, diphtheria, croup, scarlatina, measles, rötheln, chicken-pox, influenza
Somerset East	*Typhoid*, diphtheria, chicken-pox, mumps, influenza, small-pox
Pearston	*Typhoid*, *dysentery* and diarrhœa, diphtheria, rötheln, influenza
Stellenbosch	*Typhoid*, croup, influenza
Somerset West	*Typhoid*, diphtheria
Steynsburg	*Typhoid*, diphtheria, scarlatina, measles, rötheln, small-pox
Stockenstrom	*Typhoid*, *dysentery* and diarrhœa, croup, scarlatina, influenza, small-pox
Stutterheim	*Dysentery* and diarrhœa, scarlatina, measles, whooping-cough, mumps, influenza, small-pox
Sutherland	*Typhoid*, *dysentery* and diarrhœa, diphtheria, chicken-pox
Swellendam	*Typhoid*, typho-malarial fever, *dysentery*, diarrhœa, scarlatina, measles, chicken-pox
Tarka	*Typhoid*, *dysentery* and diarrhœa, diphtheria, croup, scarlatina, measles, rötheln, chicken-pox, small-pox
Tulbagh	*Typhoid*, *dysentery* and diarrhœa, diphtheria, scarlatina, small-pox
Uitenhage	*Typhoid*, *dysentery* and diarrhœa, diphtheria, scarlatina, measles, rötheln, chicken-pox, whooping-cough, mumps, influenza, small-pox
Uniondale	*Typhoid*, *dysentery* and diarrhœa, diphtheria, croup, chicken-pox, influenza
Van Rhynsdorp	*Typhoid*
Victoria West	*Typhoid*, scarlatina
Victoria East	*Dysentery* and diarrhœa, croup, whooping-cough, mumps, influenza, small-pox
Willowmore	*Typhoid*, diphtheria, croup, measles, chicken-pox, influenza
Steytlerville	*Typhoid*, typho-malarial fever, *dysentery* and diarrhœa, diiphtheria, croup, influenza, small-pox
Wodehouse	Diphtheria, scarlatina, measles, whooping-cough, mumps, influenza
Worcester	*Dysentery* and diarrhœa, diphtheria, chicken-pox, small-pox
Wynberg	*Typhoid*
Rondebosch	*Typhoid*, diphtheria, scarlatina, measles

APPENDIX II.

EXTRACT FROM THE REPORT OF THE MEDICAL OFFICER OF HEALTH FOR THE CAPE COLONY FOR THE YEAR 1896.

Table VIII.

Giving a comparison of the "crude" rates of mortality per 1,000 persons, from certain chief causes, among the European and coloured population of the thirty-two chief towns of the Colony, and of the population of England and Wales.

	England and Wales, 1895.	Chief Towns of Colony, 1896.	
		Europeans.	Coloured.
Class I.			
Typhoid fever, continued fever, "fever" ..	0·180	1·18	1·80
Diarrhœal diseases	0·902	1·84	4·71
Enteritis, gastro-enteritis	0 512	2·01	2·66

APPENDIX III.

(The Figures must be only taken as Approximate.)

Warrant Officers, N.C.O.'s, and Men. South African Field Force.

Dysentery.

Week ending—	Average Strength of Army.	Admissions.	Deaths.
From October 20, 1899, to September 28, 1900 ..	—	*11,143	*546
From October 5, 1900, to September 27, 1901 ..	—	13,151	427

* The statistics of Ladysmith and Mafeking during the siege of these places are not included.

Enteric Fever.

Week ending—	Average Strength of Army.	Admissions.	Deaths.
From October 20, 1899, to September 28, 1900 ..	—	†15,655	†3,642
From October 5, 1900, to September 27, 1901 ..	—	15,463	2,530

† Including the siege of Ladysmith, but not Mafeking.

Dysentery. (By Months.) From Week ending October 20, 1899, to Week ending September 28, 1900.

Week ending—	Admissions.	Strength of Army.*	Percentage.	Remarks.
1899—				
October 27	26	—	—	Two weeks
November 24	82	—	—	Four „
December 29	547	—	—	Five „
1900—				
January 26	504	125,707	·40	Four „
February 23	585	150,140	·39	Four „
March 30	1,550	176,618	·88	Five „
April 27	1,763	206,238	·85	Four „
May 25	1,823	215,608	·85	Four „
June 29	2,138	220,507	·97	Five „
July 27	725	229,261	·32	Four „
August 31	590	232,307	·25	Five „
September 28	810	229,869	·35	Four „
Total	†11,143	—	—	—

* Obtained from fortnightly strength compiled by A.G.
† Does not include the sieges of Ladysmith or Mafeking.

APPENDIX III—continued.

DYSENTERY. (By Months.) From Week ending October 5, 1900, to Week ending September 27, 1901.

Week ending—	Admissions.	Strength of Army.*	Percentage.	Remarks.
1900—				
October 26	1,404	229,114	·61	Four weeks
November 30	1,993	227,022	·88	Five ,,
December 28	1,626	225,102	·72	Four ,,
1901—				
January 25	1,293	213,372	·61	Four ,,
February 22	1,086	229,689	·47	Four ,,
March 29	1,190	—	—	Five ,,
April 26	1,431	—	—	Four ,,
May 31	1,842	—	—	Five ,,
June 28	420	—	—	Four ,,
July 26	246	—	—	Four ,,
August 30	240	—	—	Five ,,
September 27	380	—	—	Four ,,
Total	13,151	—	—	—

* Obtained from fortnightly strength compiled by A.G.

ENTERIC FEVER. (By Months.) From Week ending October 20, 1899, to Week ending September 28, 1900.

Week ending—	Admissions.	Strength of Army.*	Percentage.	Remarks.
1899—				
October 27	5	—	—	Two weeks
November 24	17	—	—	Four ,,
December 29	37	—	—	Five ,,
1900—				
January 26	156	125,707	·12	Four ,,
February 23	369	150,140	·25	Four ,,
March 30	1,479	176,618	·84	Five ,,
April 27	2,549	206,238	1·24	Four ,,
May 25	2,928	215,608	1·36	Four ,,
June 29	3,502	220,507	1·59	Five ,,
July 27	1,641	229,261	·72	Four ,,
August 31	1,020	232,307	·44	Five ,,
September 28	480	229,869	·21	Four ,,
Total	†14,183	—	—	—

* Obtained from fortnightly strength compiled by A.G.

† During the siege of Ladysmith 1,472 cases of enteric fever occurred. These cannot, however, be separated into admissions by months. Does not include Mafeking.

APPENDIX III—continued.

ENTERIC FEVER. (By Months.) From Week ending October 5, 1900, to Week ending September 27, 1901.

Week ending—	Admissions.	Strength of Army.*	Percentage.	Remarks.
1900—				
October 26	568	229,114	·25	Four weeks
November 30	1,213	227,022	·53	Five ,,
December 28	1,665	225,102	·74	Four ,,
1901—				
January 25	2,121	213,372	·99	Four ,,
February 22	2,119	229,689	·92	Four ,,
March 29	2,177	—	—	Five ,,
April 26	1,484	—	—	Four ,,
May 31	2,322	—	—	Five ,,
June 28	885	—	—	Four ,,
July 26	324	—	—	Four ,,
August 30	328	—	—	Five ,,
September 27	257	—	—	Four ,,
Total	15,463	—	—	—

* Obtained from fortnightly strength compiled by A.G.

WEEKLY Admissions of Dysentery and Enteric Fever into Hospitals at Bloemfontein from Week ending March 16 to Week ending August 3, 1900.

Week ending—	Dysentery.	Enteric Fever.
March 16	17	12
March 23	15	80
March 30	40	158
April 6	59	163
April 13	51	367
April 20	70	256
April 27	65	219
May 4	47	205
May 11	102	567
May 18	110	672
May 25	81	244
June 1	106	215
June 8	128	487
June 15	60	213
June 22	75	221
June 29	52	149
July 6	27	90
July 13	26	102
July 20	23	53
July 27	13	54
August 3	24	88

APPENDIX IV.

The name or number of the Hospital should be *boldly* written here _____

Army Form A. 28.

Return of Sick of Troops on Field Service

in _____

Dated _____ day of _____, 1____.

at _____.

When used as a Daily Return in the Field, only such details as may be considered necessary need be filled in.

Diseases.	Commissioned Officers. Strength _____									Warrant Officers, Non-Com. Officers and Men. Strength _____								
	Remained last Return.	Admitted into Hospital.	*Transferred from other Hospitals or Sick Convoys.*	Died. In Hospital	Died. Out of Hospital.	Discharged. To Duty.	Discharged. Otherwise.	*Transferred to other Hospitals or Sick Convoys.*	Remaining in Hospital.	Remained last Return.	Admitted into Hospital.	*Transferred from other Hospitals or Sick Convoys.*	Died. In Hospital.	Died. Out of Hospital.	Discharged. To Duty.	Discharged. Otherwise.	*Transferred to other Hospitals or Sick Convoys.*	Remaining in Hospital.
General diseases—																		
Small-pox																		
Measles																		
Scarlet fever																		
Plague																		
Dengue																		
Influenza																		
Mumps																		
Diphtheria																		
Simple continued fever																		
Enteric fever																		
Mediterranean fever																		
Cholera																		
Choleraic and epidemic diarrhœa																		
Dysentery																		
Yellow fever																		
Intermittent fever																		
Remittent fever																		
Erysipelas																		
Septicæmia																		
Pyæmia																		
Tubercular diseases																		
Primary syphilis																		
Secondary syphilis																		
Gonorrhœa																		
Alcoholism																		
Rheumatic fever																		
Rheumatism																		
Other general diseases																		
Local diseases—																		
Diseases of the nervous system																		
Conjunctivitis																		
Other diseases of eye																		
Disordered action of heart																		
Other diseases of circulatory system																		
Bronchitis																		
Pneumonia																		
Pleurisy																		
Other diseases of respiratory system																		
Diarrhœa																		
Sore throat																		
Tonsillitis																		
Inflammation of intestines																		
Inflammation and congestion of liver																		
Jaundice																		
Other diseases of digestive system																		
Diseases of the urinary system																		
Soft chancre																		
Other local diseases																		
Injuries—																		
Sunstroke and heat apoplexy																		
Received in action—																		
Gunshot																		
Other																		
Self-inflicted																		
Other injuries																		
Poisons																		
Not yet diagnosed																		
Total																		

DETAIL of Corps whose sick are treated in the _____ Hospital.

(Dates of arrival or departure at the Station during the week to be specified after each Corps or detachment over 50 men.)

Corps.	Average Strength.		Commissioned Officers.									Warrant Officers, Non-Com. Officers and Men.								
	Officers.	Warrant Officers, Non.-Com. Officers and Men.	Remained last Return.	Admitted into Hospital.	*Transferred from other Hospitals or Sick Convoys.*	Died.	Discharged. To Duty.	Discharged. Otherwise.	*Transferred to other Hospitals or Sick Convoys.*	Remaining in Hospital	Average Daily Sick.	Remained last Return.	Admitted into Hospital.	*Transferred from other Hospitals or Sick Convoys.*	Died.	Discharged. To Duty.	Discharged. Otherwise.	*Transferred to other Hospitals or Sick Convoys.*	Remaining in Hospital.	Average Daily Sick.
Total																				

RETURN of all Men *not* belonging to Her Majesty's Regular Troops (including Militia,* Volunteers,* Followers, &c., and also Royal Marines and Seamen) who are not included in the foregoing, but have been under Treatment in Hospital.

Regiment or Branch of Service.	Disease.	Number Admitted to Hospital.	Number Discharged from Hospital.	Number Died.	Remarks.

NOTE.—Should the space in the above table be insufficient, a separate return may be rendered.

* Statistics of *Embodied* Militia; *Enlisted* Yeomanry and Volunteers will be included with those of the Regular Troops.

SICK OFFICERS.

Slip to be attached when necessary.

Corps.	Battery or Battalion, &c.	Rank.	Name.	Age.	Service.	Disease.	Date of being placed on Sick List	Date of being taken off Sick List.	Result.

NOMINAL RETURN of Deaths of Officers, Warrant Officers, Non-commissioned Officers, and Men during the Week.

(Officers to be entered first, and a line ruled after the name of the last Officer.)

Corps.	Battery or Battalion, &c.	Rank.	Name.	Age.	Service.	Date of Death.	Place of Death.	Disease.

REMARKS.—(Stating where there is any special prevalence of disease, cause of such prevalence, and Corps most affected. Further remarks, if necessary, to be made on a separate sheet.)

Place _____

Signature _____

Date _____

ON HER MAJESTY'S SERVICE.

MEDICAL DIVISION.

The Under Secretary of State,
War Office,
London, S.W.

This Return being meant to furnish the Director-General, Army Medical Service, with the latest information respecting the health of Troops in the Field, should not be sent through the Principal Medical Officer, but be posted *direct* to London each Saturday through whatever seems to the Medical Officer likely to be the most expeditious channel. Duplicate copies are to be sent regularly to the Principal Medical Officer each Saturday.

This Return is *not* to be enclosed in an Envelope.

This form is equally applicable for returns by Medical Officers in charge of Hospitals and by Principal Medical Officers.

APPENDIX V.

RESULTS OF BACTERIOLOGICAL EXAMINATION OF TREVENNA WELL WATER

1. Sediment containing bacteria of different kinds.
2. Cultures contained a number of different bacteria.
3. From the cultures of different microbes two special microbes were isolated, viz., the colon bacillus and the typhoid fever bacillus :—

(*a*) *Characters of the Colon Bacillus isolated.*—Small, thick bacillus, non-motile, reddens and coagulates litmus milk, forms abundant gas in sugar gelatine, and in ordinary gelatine grows well in 3/10 Parietti, gives a strong indol reaction in 48 hours in bouillon culture, shows a yellowish growth on potatoes and grows in gelatine plate cultures as dark brown, coarsely granular circular colonies.

(*b*) *Characters of the Typhoid Bacillus isolated.*—Small, slender bacillus, varies in size growing at times in threads, actively motile, does not redden nor coagulate litmus milk, forms no gas in sugar gelatine, grows on gelatine plates as pale, colourless, small, generally circular colonies slightly granular in appearance; on the surface of the gelatine forms a leaf-like expansion, grows on gelatine slope along track of needle but shows no disposition to spread laterally, exhibits on potato a slight buff coloured growth, but does not grow in 3/10 Parietti, gives no indol reaction, agglutinates 1 to 50 and 1 to 100 respectively with blood serum from two typhoid patients.

ADMISSION AND DISCHARGE BOOK.

_____ *HOSPITAL.*

Index number of Admissions. Transfers are not to be numbered consecutively with the Admissions, but should be left un-numbered, or numbered in red ink as a separate series.	Regiment, Battalion, Corps, or other Unit.	Squadron, Battery, or Company.	Regimental No.	Rank.	Surname.	Christian name.	Completed Years of—		Completed Months with Field Force.	DISEASES (Wounds and Injuries in Action to be entered accord to classificatio on fly-leaf.
							Age.	Service.		

VI.

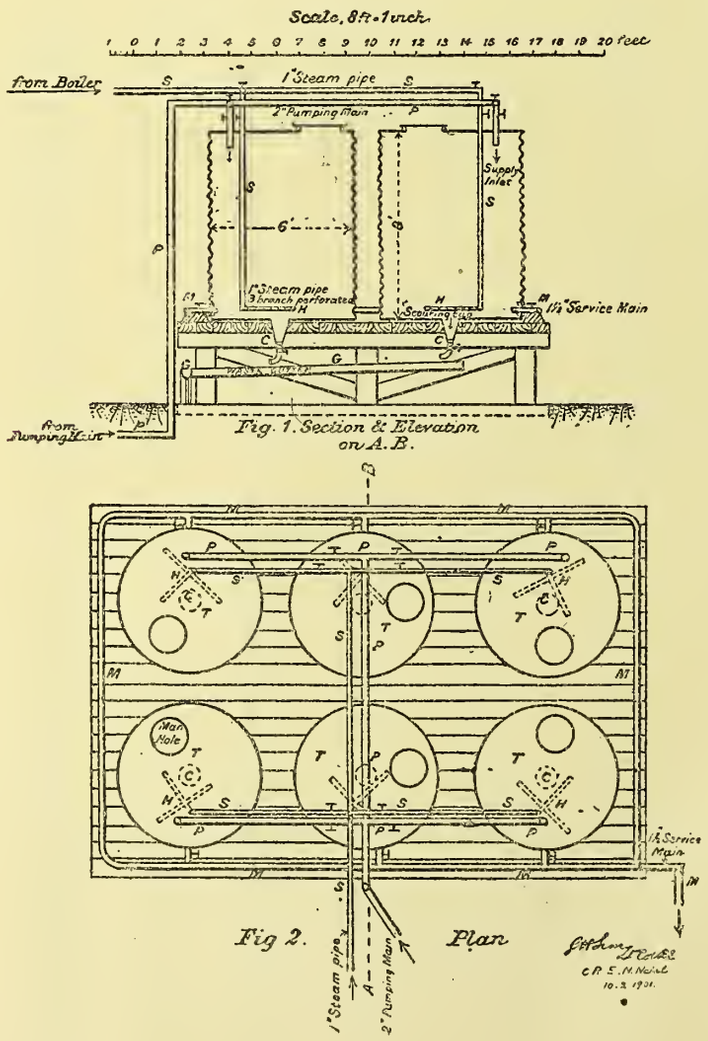
FIELD SERVICE.

Date of Admission.		Date of Discharge.			Date of Transfer.				Number of Days under Treatment.	Number or Designation of Ward in which Treated.	Religion.	OBSERVATIONS.
					To—		From—					
For original Disease.	By new Disease supervening.	To Duty.	By new Disease supervening.	By Death.	Sick Convoy.	Other Hospitals.	Sick Convoy.	Other Hospitals.				Number and page of case book to be quoted for all cases recorded in it. In transfers the designation of the hospital or sick convoy, to which or from which transferred, must be noted here, and any other facts bearing on the man's destination; also in movable field hospitals the place where the admission, &c., took place should be indicated. Place of action to be noted in cases of wounds and injuries received in action.

APPENDIX VII.

Sterilising Water for Ladysmith.—January, 1901.

The water of the Klip River at Ladysmith is more like liquid mud than water; it absolutely chokes a Berkefeld filter, working with 25 feet head in an hour. The army medical authorities attributed the notoriety of Ladysmith for epidemics of enteric fever among the troops, and dysentery as well, to the use of the Klip water. It was considered desirable to supply one gallon per head of sterilised water per day for dietetic purposes for 2,000 Boer prisoners, 500 troops, 100 sick in hospital, and 100 followers, &c.; total, 2,700 persons.



The traction engines that were being used to work the electric light dynamos for the Boer prison would be available during the day, so they were used to sterilise the water by steam heating.

The diagram shows the arrangement adopted.

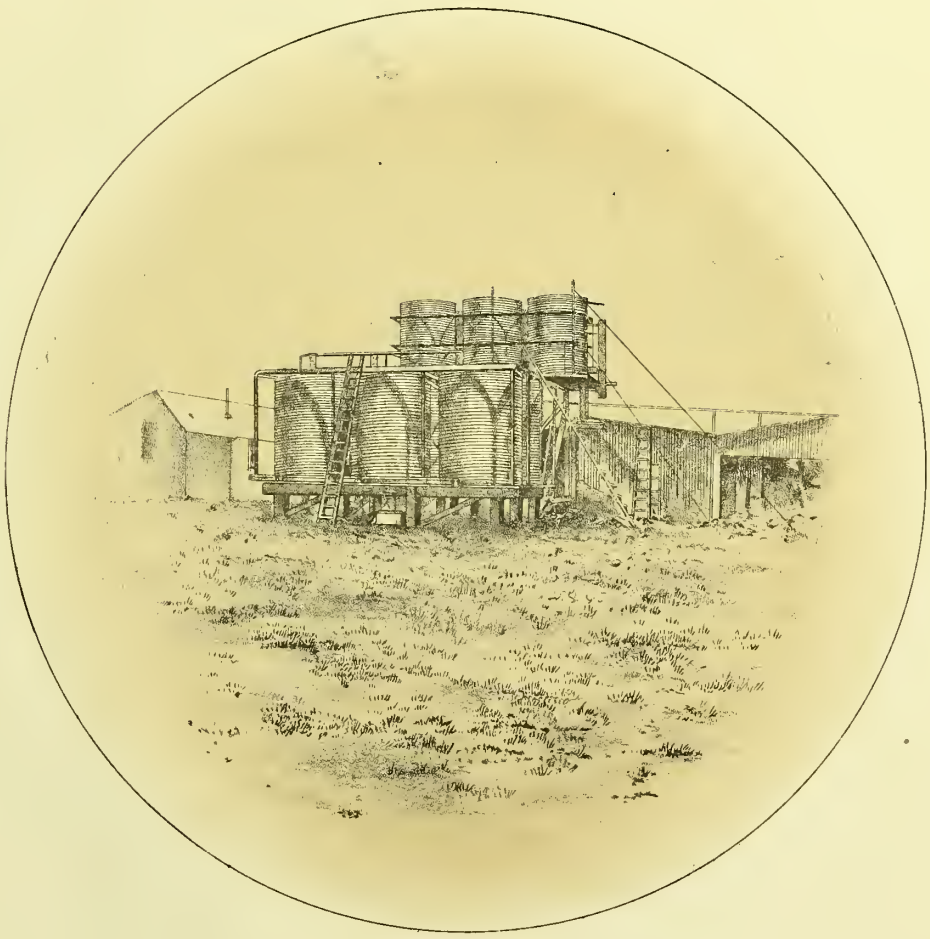
On a wooden platform were erected six cylindrical tanks, TT, each 8 feet high and 6 feet diameter, made of corrugated-iron sheets riveted and soldered; top and bottom of plain galvanised sheet-iron.

A 2-inch pumping main, PP, supplied the water from the river. Steam was introduced by a 1-inch steam pipe, SS, passing to the bottom of the tanks and branching out into three arms, HHH, pierced with small holes. A light

To face page 114

Apparatus For Sterilising Water

At Tintown Ladysmith. (Established before the War.)



1930 5 1902.

Weller & Graham Ltd Litho. London.

framework of wood was added to support the pipes, but this is not shown in the diagram, to avoid complication.

The water having been heated to 190° to sterilise it, powdered alum was thrown in, and the mud having been precipitated to the bottom, the cleared water was drawn off by $1\frac{1}{2}$-inch pipes, MM, into a service main laid all over the camp. A scouring tap, C, and waste gutter, G, were provided to run off the mud sediment and facilitate the cleaning of the tank. The system of pipes was arranged so that each tank could be used independently, or any number together.

The tanks hold each about 1,350 gallons "available."

Each tank takes about two hours to raise to 190° F., with 85 lbs. steam pressure in the boilers.

A pound and a quarter of powdered alum precipitates the mud, the water only remaining slightly milky.

The water in one tank requires about 36 hours to cool to the temperature of water outside. For hospital use the water is further passed through a Pasteur-Chamberland filter.

By the above system there is no possibility of the water being contaminated after it is sterilised.

Six tanks are required for a daily supply of 2,700 gallons, so that the routine is :—

Half a day cleaning, filling, and sterilising two tanks ; one and a-half days cooling ; one day emptying.

G. H. SIM, *Lieut.-Colonel, R.E.,*
C.R.E., Northern Natal.

Ladysmith, *February* 10, 1901.

APPENDIX VIII.

Results of Boring for Water for Military from November, 1899, to August, 1901.

Date of Completion.	Locality.	Diameter of Borehole.	Depth of Borehole.	Strata Pierced.	Quality of Water Tapped.	Quantity of Water Tapped per 24 Hours.	Depth from Surface to which Water Rises.	Supply of Water, how Utilised.
		Inches.	Feet.			Gallons.	Feet.	
1900—								
February 6..	800 yards N.W. of Enslin Station, C.C.	3⅛	52	Black shale and dolerite ..	..	..	..	Abandoned, struck dolerite
„ 7..	About 1,500 yards S.W. of Graspan Station, C.C.	3⅛	(Well, 22) 16	Blue shale and metamorphic and dolerite	Fresh	8,000	26	Convoys passing and General Tucker's Division whilst stationed at Graspan
„ 12..	About 1 mile S.E. of Graspan Station, C.C.	3⅛	15	Subsoil, blue shale and dolerite	..	..	..	Abandoned, struck dolerite
„ 17..	1,300 yards S.W. of Graspan Station, C.C.	3⅛	29½	Subsoil, blue shale and dolerite	..	..	..	„ „
„ 18..	1,300 yards S.W. of Graspan Station, C.C.	3⅛	17½	Subsoil, blue shale and dolerite	..	..	..	„ „
„ 7..	¾ mile S.E. of Enslin Station, C.C.	3⅛	34	Sandstone intermixed with lime	Perfectly fresh	11,520	28	Two convoys of 100 wagons, each wagon 16 oxen, besides numerous horses, and men stationed at Enslin prior to Lord Roberts' march for the relief of Kimberley, were watered at these three boreholes
„ 9..	¾ mile S.E. of Enslin Station, C.C.	3⅛	45	Sandstone intermixed with lime	„	11,520	28	
„ 14..	¾ mile S.E. of Enslin Station, C.C.	3⅛	47	Sandstone intermixed with lime	„	11,520	28	
„ 28..	500 yards N.E. of Honeynest Kloof Station, C.C.	3⅛	118	Sandstone, limestone, black and metamorphic shale	Slightly sulphurous	6,000	20	The O.C. R.E. stationed there stated that the borehole was the salvation of the camp
April 7.	50 yards S W. Military Camp at Warrenton, C.C.	3⅛	65	Gravel beds, lime and black shale	Perfectly fresh	11,520	22	Used by all the troops in camp at Warrenton, no other procurable
May 5..	5 yards S. of the Military Camp at Warrenton, C.C.	3⅛	68	Gravel beds, lime and black shale	„	11,520	28	Used by all the troops in camp at Warrenton, no other procurable
March 3..	Military Hospital at Sterkstroom, C.C.	3⅛	153	Subsoil, red shale and grey sandstone	„	13,200	24	For hospital use
April 1..	Springfontein Station, O.R.C.	3⅛	105	Subsoil, grey sandstone, drab schist and blue shale	Very good ..	5,000	8	For men stationed in camp

„	14..	Bethany Station, O.R.C. ..	3⅛	33	Grey sandstone, clay and red shale	„ ..	12,960	12	„ „
„	28..	Karee Siding, O.R.C. ..	3⅛	79	Yellow and grey sandstone and blue shale	„ ..	12,000	20	All men and animals with General Tucker's Division. No other water procurable except a well wherein the water was polluted by surface contamination
May	5	„ „ ..	3⅛	53	Yellow and grey sandstone and blue shale	„ ..	12,000	24	
April	27..	Willow Trees, Bloemfontein Commonage, O.R.C.	6, 4½, 3⅛	48½	Subsoils, grey sandstone and dolerite	Pronounced by P.M.O. Portland hospital to be of excellent quality	96,000	2¾	When waterworks at Sannah's Poort were taken by the enemy, the supply obtained in this borehole was forced into town mains, and so distributed amongst the various camps
May	14..	250 yards above the Willow Trees at Bloemfontein, O.R.C.	6, 4½, 3⅛	180	.. ..	Excellent ..	35,000	9	Holes bored by the O.F.S. Government, reamed and cleaned by P.W.D. staff of all débris, and water was daily used for the hospital authorities situated in immediate neighbourhood
„	28..	3 yards from the last borehole at Willow Trees, O.R.C.	3⅛	180	.. ..	„ ..	14,000	9	
„	8..	About 1,000 yards N.W. of Willow Trees in 6th Division Camp, O.R.C.	3⅛	56½	Sandstone and shale.. ..	„ ..	11,520	26	For men stationed in the 6th Division camp
April	16..	Sussex Hill, 2½ miles S.E. of Bloemfontein, O.R.C.	3⅛	50	„ „	„ ..	11,520	20	This borehole supplied all men and horses stationed at Sussex Hill
May	27..	9th Division Camp near Magazine at Bloemfontein, O.R.C.	3⅛	204	„ „	„ ..	12,000	40	
June	5..	Local Supply Depôt S.E. of Bloemfontein, O.R.C.	3⅛	54	Sandstone and red shale ..	„ ..	17,000	20	Water used by local bakeries, also by animals attached to local supply and Transport Company
„	3..	Mr. Steyn's Farm near Ferreira's Siding 6 miles south of Bloemfontein, O.R.C.	3⅛	36	Shale and grey sandstone ..	„ ..	25,000	10	About 5,000 horses were removed from Bloemfontein Commonage to Mr. Steyn's farm, after the water was tapped, and all were located there. The water was led in troughs direct from the pump for the sick animals
April	30..	Rustfontein Farm about 3 miles N.E. of Bloemfontein, O.R.C.	3⅛	36	.. ..	..	..	..	Abandoned, struck dolerite
1899—									
December	6..	Putter's Kraal, C.C... ..	3⅛	13	Clay and dolerite	..	..	..	„ „
„	10..	„ „	3⅛	28	Sandstone and shale.. ..	..	..	..	Abandoned owing to removal of camp

RESULTS of Boring for Water for Military from November, 1899, to August, 1901—continued.

Date of Completion.	Locality.	Diameter of Borehole.	Depth of Borehole.	Strata Pierced.	Quality of Water Tapped.	Quantity of Water Tapped per 24 Hours.	Depth from Surface to which Water Rises.	Supply of Water, how utilised.
		Inches.	Feet.			Gallons.	Feet.	
1899—								
December 13..	Putter's Kraal, C.C.	3⅛	23	Clay and red shale	..	..	..	Abandoned owing to removal of camp
„ 30..	Queen's Town, C.C.	3⅛	97	Sandstone and shale.. ..	Good	8,640	57	Camp purposes
1900—								
January 10..	„ „	3⅛	157	Sandstone and quartzite ..	..	..	..	Abandoned, no water
May 10..	Remount Siding, C.C. ..	3⅛	145	Clay and shale	Good	28,000	17	Horse depôt
June 22..	Norval's Pont, C.C.	3⅛	116	Shale and sandstone.. ..	„	12,000	25	Camp purposes
July 7..	„ „	3⅛	43½	Sandstone	..	..	..	Abandoned by order O.C. R.E.
„ 14..	„ „	3⅛	105	Sandstone and shale.. ..	Good	1,200	43	Hospital purposes
„ 24..	„ „	3⅛	26	Sandstone	„	15,000	Flowing	Camp purposes
August 3..	„ „	3⅛	50	Sandstone and shale.. ..	„	1,200	24	„ „
„ 30..	Pretoria, Transvaal	3⅛	160	Sandstone and clay slate ..	..	..	..	Abandoned, no water
January 28..	Rensburg, C.C.	3⅛	37	Sandstone	Fresh	20,000	10	Camp purposes
February 2..	Bushman's Hoek, Stormberg, C.C.	3⅛	109	Sandstone and shale.. ..	„	400	4	„ „
„ 2..	Queen's Town, C.C.	3⅛	34	Quartzite	..	..	..	Abandoned, no water
1899—								
December 22..	Sterkstroom, C.C.	3⅛	68	Sandstone and shale.. ..	Good	12,000	16	Camp purposes
1900—								
January 3..	„ „	3⅛	83	„ „	„	10,000	12	„ „
„ 29..	„ „	3⅛	153	„ „	„	2,000	8	„ „
February 18..	Naauwpoort, C.C.	3⅛	27	Sandstone	..	..	..	Abandoned, no water
„ 28..	„ „	3⅛	40	„	Good	20,000	6½	Hospital purposes
April 14..	Remount Siding, C.C. ..	6, 4½, 3⅛	167	Clay and shale	„	7,200	60	Abandoned
January 10..	Bushman's Hoek at Stormberg, C.C.	3⅛	59	„ „	„	500	12	Camp purposes
1899—								
December 9..	Bushman's Hoek at Stormberg, C.C.	3⅛	43	„ „	„	500	4	„ „
„ 4..	Putter's Kraal, C.C.	3⅛	39	Sandstone	.. ..	6,000	4	„ „

1900—									
September	15..	Johnstone's Kopje, Pretoria	3⅛	98	Sandstone and shale.. ..	„	8,640	12	„ „
„	24..	Reitfontein, Pretoria ..	3⅛	16	Sandstone and dolerite ..	.. ..	..	..	Abandoned, struck dolerite
October	1..	Kroonstaad, O.R.C.	3⅛	56	Shale	Good	5,000	18	Camp purposes
„	7..	„ „	3⅛	70	Sandstone and shale.. ..	„	11,500	8	„ „
„	14..	Kroonstaad Kopjes Siding, O.R.C.	3⅛	43	Shale	„	11,500	18	„ „
„	15..	Lieuwspruit, O.R.C.	3⅛	15½	Shale and dolerite	..	..	..	Abandoned, struck dolerite
„	20..	„ „	3⅛	76	Shale	Good	11,500	12	Camp purposes
„	30	Vredefort Road, O.R.C. ..	3⅛	90	Sandstone	„	6,000	43	„ „
„	4..	Rietfontein, Pretoria.. ..	3⅛	92	Shale	„	25,400	56	„ „
„	13..	Cable Hill, Pretoria	3⅛	22	Clay	„	6,000	8	„ „
November	7..	Virginia, O.R.C.	3⅛	44	Sandstone and shale.. ..	„	11,500	22	„ „
„	7..	Pienaar's River, Transvaal ..	3⅛	92	Shale	„	5,600	27	„ „
December	10..	Ventersburg Road, O.R.C. ..	3⅛	87	Sandstone	„	10,000	30	„ „
„	26..	Vredefort Road, O.R.C. ..	3⅛	120	„	„	Supply weak	50	„ „
„	31..	„ „ ..	3⅛	129	„	„	10,000	17	„ „
1901—									
January	14..	Kroomellenburg Sprnit, O.R.C.	3⅛	30	Sandstone and dolerite ..	..	..	..	Abandoned, struck dolerite
„	22..	„ „	3⅛	73	Sandstone and quartzite ..	Good	8,640	28	Camp purposes
„	30..	East Hill, Kroonstad, O.R.C.	3⅛	104	Sandstone, shale and slate ..	„	6,912	32	„ „
February	23..	Kroonstad, O.R.C.	3⅛	180½	„ „ ..	„	30,000	22	„ „
„	5..	Steynsburg, C.C.	3⅛	67	Sandstone and shale.. ..	„	5,760	2½	„ „
January	26..	Wolvehoek, O.R.C.	3⅛	9½	Sandstone, quartzite and dolerite	..	..	..	Abandoned, struck dolerite
„	30..	„ „	3⅛	22	Sandstone, quartzite and dolerite	..	Weak supply	16	„ „
February	4..	„ „	3⅛	22	Sandstone, quartzite and dolerite	..	..	..	„ „
„	9..	„ „	3⅛	41	Sandstone, quartzite and dolerite	Good	2,880	28	Camp purposes
March	20..	Richmond, C.C.	3⅛	70	Shale	„	5,760	36	„ „
„	20..	Bloemfontein, O.R.C. ..	3⅛	91	Sandstone and shale.. ..	„	2,880	25	„ „
April	30..	Camp at Deaar, O.R.C. ..	3⅛	83	„ „	„	11,500	15	„ „
„	14..	„ „ ..	3⅛	54	Shale	„	12,000	15	„ „
„	25..	Left bank of the Vaalsche River, O.R.C.	3⅛	377	.. ..	..	..	..	Abandoned, struck dolerite
May	18..	Left band of the Vaalscha River, O.R.C.	3⅛	92	Sandstone and shale.. ..	Good	4,000	30	Camp purposes
February	26..	Roodeval Spruit Camp, O.R.C.	3⅛	125	Shale and basalt	„	12,960	26	„ „
May	7..	Serfontein Camp, O.R.C. ..	3⅛	162	Shale	..	Very weak	..	Abandoned owing to supply being too weak

Results of Boring for Water for Military from November, 1899, to August, 1901—continued.

Date of Completion.	Locality.	Diameter of Borehole.	Depth of Borehole.	Strata Pierced.	Quality of Water Tapped.	Quantity of Water Tapped per 24 Hours.	Depth from Surface to which Water Rises.	Supply of Water, how Utilised.
		Inches.	Feet.			Gallons.	Feet.	
1901—								
May 7..	Holfontein Camp, O.R.C. ..	$3\frac{1}{8}$	64	Sandstone and shale.. ..	Good	12,960	10	Camp purposes
April 12..	America Siding, O.R.C. ..	$3\frac{1}{8}$	7	Dolerite	..	..	..	Abandoned, struck dolerite
„ 15..	„ „ ..	$3\frac{1}{8}$	6	„	..	..	..	„ „
„ 25..	„ „ ..	$3\frac{1}{8}$	94	Clay and shale	Good	12,960	20	For use of troops
May 31..	Kroonstad Camp, O.R.C. ..	$3\frac{1}{8}$	153	Sandstone, shale and basalt..	„	2,160	40	Camp purposes
June 9..	Jagersfontein Road, O.R.C..	$3\frac{1}{8}$	31	Shale and ironstone	„	12,000	10	„ „
„ 20..	Kroonstad, O.R.C.	$3\frac{1}{8}$	130	Sandstone and shale.. ..	„	1,440	58	„ „
„ 25..	Kafir River Bridge, O.R.C. ..	$3\frac{1}{8}$	103	„ „	„	6,000	20	„ „
July 13..	Glen Station, O.R.C.. ..	$3\frac{1}{8}$	103	Clay, sandstone and shale ..	„	10,000	54	„ „
June 3..	Aliwal North, C.C.	$3\frac{1}{8}$	127	Sandstone and shale.. ..	„	3,360	38	„ „
July 4..	„ „	$4\frac{1}{2}$, $3\frac{1}{8}$	33	„ „	„	17,000	21	„ „
„ 19..	„ „	$3\frac{1}{8}$	60	„ „	Slightly brackish	16,000	18	„ „
„ 3..	Middelburg, C.C.	$3\frac{1}{8}$	94	Indurated sandstone ..	..	..	..	Doctor of garrison stopped the work
„ 13..	„ „	$3\frac{1}{8}$	17	Limestone and sand.. ..	Good	25,000	12	Camp purposes
„ 26..	Springfontein, O.R.C. ..	$3\frac{1}{8}$	53	Sandstone and shale.. .	„	17,280	7	„ „
„ 15..	Aliwal North, Refugee Camp, C.C.	$4\frac{1}{2}$, $3\frac{1}{8}$	80	Limestone, sandstone and shale	„	20,400	50	„ „
April 14..	Standerton, Transvaal ..	$3\frac{1}{8}$	203	Shale, quartzite and dolerite	„	1,000	190	„ „
„ 2..	„ „ ..	$3\frac{1}{8}$	18	„ „	..	..	..	Abandoned, struck dolerite
„ 4..	„ „ ..	$3\frac{1}{8}$	12	„ „	..	..	..	„ „
„ 5..	„ „ ..	$3\frac{1}{8}$	16	„ „	..	..	..	„ „
„ 10..	„ „ ..	$3\frac{1}{8}$	30	„ „	..	..	..	„ „
„ 30..	„ „ ..	$4\frac{1}{2}$, $3\frac{1}{8}$	128	Shale and sandstone.. ..	Good	10,000	110	Camp purposes
January 27..	Komati Poort, Transvaal ..	$3\frac{1}{8}$	73	.. ..	..	..	..	Abandoned
	Kaapmuiden, Transvaal ..	$3\frac{1}{8}$	Still in progress					
	„ „ ..	$3\frac{1}{8}$	120	Shale and dolerite	..	..	..	Abandoned, struck dolerite
	Pietersberg, Transvaal ..	$3\frac{1}{8}$	Still in progress					

APPENDIX IX.

Instructions to Officers in Medical Charge of Units.

As officers in medical charge of regimental units may not have copies of the regulations for Army Medical Services available for reference, the following notes and extracts from these regulations are furnished for guidance :—

(1) *Returns.*—No returns are required except when specially ordered.

(2) *Routine duties.*—Officers will enter concisely in Army Book 39 (a copy of which will be found in the lid of No. 2 Field Medical Pannier) the names, diseases, and disposal of all soldiers reporting sick ; they will make a record of any recommendation which it may be necessary to make to the commanding officer of the unit, and the result of such recommendation ; they will also make brief notes of any important occurrence connected with their duties which it may be advisable to have available for future reference. This book, thus entered up, will be produced at all visits and inspections by the army corps and divisional principal medical officers.

(3) *Sanitation.*—The greatest attention will be paid at all times to camp sanitary duties. The *personnel* of the unit, and the general conditions of the camp will be under the close and constant supervision of the Medical Officer.

He will explain to all concerned that the diseases most liable to attack troops while campaigning in South Africa (viz., enteric fever, dysentery, &c.), can only be incurred by swallowing the poison either in food or drink. It is advisable, therefore, that all food should be thoroughly cooked, and carefully guarded against contamination by flies and dust: that all water should be either boiled, or filtered through a Berkefeld filter (charcoal filters are worse than useless) before being drunk.

Full instructions regarding the method of working the Berkefeld filter—which will be supplied to each company or its equivalent—will be found attached to the lid of the pannier containing the filter.

It must not be forgotten that one of the chief sources of infection in camping grounds is the urine of people who are suffering from, or have suffered from, enteric fever; and, in addition to the usual precautions required in connection with the water supply, such as boiling and filtration, the daily use of disinfectants in all latrines, urine tubs, soakage pits, &c., becomes essential. For this purpose quicklime is the best material to use. It should be added in the form of freshly prepared milk of lime (one part hydrate of lime to eight parts water). The quantity to be added to urine tubs, soakage pits, latrines, &c., should be roughly in the proportion of one part of milk of lime to 20 parts of the contents of buckets, receptacles, pits, &c. The milk of lime should also be freely sprinkled on the surface of the soil in the neighbourhood of latrines and wherever surface pollution is likely to take place.

(4) *Duties in the field.*—While placing every check against men reporting themselves sick unnecessarily, or passing to the field hospitals without due cause, the Medical Officer will be careful that no man requiring hospital treatment, or really unfit for duty, is allowed to remain at the front with his unit.

When an action is expected, the trained stretcher bearers (two per company) will be placed at his disposal; they will leave their rifles and valises in the carts allotted for regimental medical purposes, put on the stretcher-bearer's armlets, take the stretchers, and proceed under his direction to the scene of action.

The lance corporal will also accompany him, carrying the medical companion and water bottle and the surgical haversack. The private will remain in charge of the cart, so that the field medical panniers may be available during or immediately after the action.

Whenever opportunity occurs, the officer in medical charge of a unit should apply to the officer commanding to place the stretcher-bearers at his disposal for drill and instruction. In severe actions the Medical Officer will only afford such temporary aid to the wounded as may be within his power, until they are succoured by the bearer companies, and will not undertake any serious operations.

In order to replenish the medical equipment, the Medical Officer will requisition when necessary upon the nearest field hospital or depôt of Medical Stores.

W. D. WILSON,
Surgeon-General, Principal Medical Officer,
Army Corps.

Army Headquarters,
South Africa,
November 8, 1899.

APPENDIX X.

EXTRACTS FROM ARMY AND 6TH DIVISION ORDERS, EXTENDING FROM JANUARY 22 TO MAY 31, 1900, BEARING ON MEDICAL AND SANITARY ADMINISTRATION.

I.—*Duties of Medical Officers as regards Regimental and Field Medical Units.*

Business visit.

1. The principal medical officer will receive any officer who may desire to see him on business at this office daily, at 9.30 a.m.

Copying orders.

2. Medical officers in charge of regimental units will send their lance-corporals and officers in charge medical units their clerks daily to principal medical officer's office, at 4 p.m., to copy orders.

Exceptional ability: warrant officer, non-commissioned officers and men.

3. Officers commanding field medical units will take particular care to bring to the notice of the principal medical officer at the termination of the campaign the names of the warrant, non-commissioned officers and men, who may show exceptional ability and zeal in the performance of their duties in the field.

Invalids for garrison duty.

4. The following extract from Principal Medical Officer, Field Force, 529/00, dated February 20, is published for information :—

"With a view to prevent waste of the troops in South Africa by sending home to England men suffering from slight defects, it has now been ruled that all men who may not be capable of taking the field, but who are fit for garrison duty, are to be kept in the country. There are at present a large number of such cases in hospital; these are all to be discharged and returned as fit for garrison duty.

"Medical officers will be held responsible that men suffering from such defects as flat feet, rupture, varicose veins, corns, &c., and who can perform garrison duty, are not to be sent to England as invalids. My letter of November 7, 1899, Principal Medical Officer, F.F./12/99, is cancelled."

Brassards worn.

5. On an action being imminent, brassards will be worn on the left arm by all medical officers attached to staff and regimental units, and by the personnel of medical units. Swords and revolvers will not be carried on such occasions; these will be left with personal baggage.

Exercise regimental stretcher bearers.

6. Medical officers in charge of regimental units should constantly exercise the regimental stretcher bearers in stretcher drill and "First Aid" to wounded.

The use and mode of application of 1st field dressing are also to be explained, at a convenient opportunity, to all concerned.

Rulings.

7. Questions having arisen on the following point, the decision of the Field-Marshal, Commanding-in-Chief, is published for general guidance. "The two stretcher bearers per company of infantry should be warned to wear brassards."

Stretcher bearers duties.

8. The regimental stretcher bearers, when in standing camp, will be available for ordinary duty. On the march, however, and in action, they will be under the immediate command of the regimental medical officer, and fall in behind the medical cart.

Inspection of men's feet.

9. Officers commanding regimental units—R.A. and R.E. included—will pay particular attention to the condition of men's feet, with a view to maintaining their marching powers. Frequent inspections should be held, and cleanliness promoted by every possible means. The above remarks also apply to officers commanding field medical units.

Flannel belts, wearing of.

10. The attention of medical officers in charge of regiments or other units

is again drawn to the necessity of seeing that the men of their corps are not only in possession of, but wear their flannel belts. This can only be ensured by frequent and sudden inspections.

A large amount of bowel complaints, at present so prevalent, is directly due to the neglect of the regulations on this subject.

Hair and beards trimmed.

11. The attention of officers commanding regimental and medical units is directed to the necessity of the non-commissioned officers and men under their command keeping their hair closely cropped whilst on field service.

This is absolutely essential on the grounds of cleanliness; in those cases where men wear beards, these should also be kept trimmed.

Marching orders.

12. Marching orders for field medical units will, as a rule, be issued by the brigade authorities.

Riding on ambulance and baggage wagons.

13. On the march the second in command of either bearer company or field hospital will ride in rear of the unit; this officer will see that only those persons, duly authorised, are allowed to ride in ambulance or baggage wagons.

14. Officers commanding field hospitals will instruct all non-commissioned officers and men under their command, on no account to refuse to take in any patients applying for admission without reference to an officer.

II.—*Transport.*

Driving pace—mules.

15. The attention of all concerned is called to Army Order No. 2 of February 2, directing that mule wagons should not be driven at a pace greater than 4 miles an hour. This order must be obeyed; and provost-marshals should arrest and bring forward for punishment those who infringe it.

Mule wagons—pace to move.

16. Orders have already been issued to the effect that mule wagons are to move at the walk, and not at the trot. This order is constantly disobeyed.

Officers commanding transport companies must take the necessary steps to ensure this order being understood by every man, European or native, under his command, and offenders are to be punished.

Feeding of animals.

17. D.O. No. 2 of March 4, 1900, is republished for the information of all concerned.

"The special attention of officers commanding mounted corps, and in charge of mule transport companies, is drawn to the waste and injury to the animals caused by their feeds of grain being placed on the ground, instead of on a sack or blanket, or in a nose-bag. Not only is the grain wasted, but the mixture of earth with the grain is very deleterious to horse and mule."

Mules to graze.

18. No mules except water-cart mules should be in camp after 9 a.m., at which hour they should be sent out to graze.

Riding on wagons.

19. Non-commissioned officers and men, not drivers of wagons, are forbidden to ride in baggage wagons, full or empty; they should march by the side of them.

Medical cart.

20. A cart, to be drawn by mules, for the transport of the medical equipment and stretchers has been provided for each regimental unit; it will be under the orders of the medical officer attached to the corps, and will be known as "the Medical Cart," laid down in War Establishments, 1898.

This vehicle will march with, and form portion of first line of transport, and should follow immediately behind the ammunition carts.

On no account will any article, other than those above specified be placed therein.

Medical carts—use in standing camp.

21. As soon as the necessary alterations, painting, &c., in the medical carts have been carried out, there will be no objections to these vehicles being utilised whilst in standing camp, for the transport of light articles, as long as their efficiency is not impaired.

Medical transport.

22. The following scale of transport for field hospitals and bearer companies is authorised, and will be supplied on demand, by the senior transport officer of the brigade or division concerned:—

4 buck wagons, 1 Scotch cart, 2 water carts per field hospital; 2 buck wagons, 1 water cart per bearer company; 1 extra Scotch cart, if available, will be issued to each field hospital, cavalry division.

Issue ambulances.

23. It is notified for information that the chief ordnance officer has been

authorised to issue ambulances up to 10 per bearer company, or as many as he is able to supply below this number.

Five of these are allotted to the Cape ambulance; the necessary action should be taken by all concerned.

24. Under instructions from the Secretary of State for War, the Sign of the Red Cross painted on ambulance wagons of medical units is to be 6 by $4\frac{1}{2}$ feet. Red Cross —6 ft. by $4\frac{1}{2}$ ft.

III.—*Statistics.*

25. In all returns in which patients of mounted infantry appear (except morning state of sick), the regiment or corps to which the men belong must invariably be stated. Returns.

26. Officers commanding field hospitals will furnish a return daily by 8 a.m. to this office, stating the name, corps, disease, and condition of each officer in their respective brigades under treatment in the 6th Division. Return daily officers' sick list.

27. Each field hospital will prepare a return every Saturday morning, giving following details:— Returns: Monday.

(*a*) Officers.—Numbers on the sick list, with rank, name, initial and disease of those dangerously ill.

(*b*) Warrant non-commissioned officers and men in hospital.—Regimental number, rank and name, initial and disease of those dangerously ill.

The foregoing to be telegraphed to "Casualty," Main Barracks, Cape Town.

28. Whilst on the march, correspondence, &c., will be reduced to a minimum; but officers commanding field hospitals will be very careful about keeping the admission and discharge book accurately, and also in rendering returns in connection with wounded. Correspondence on the march.

29. Deaths of all men in hospital should invariably be reported by the hospital authorities to the commanding officer of the unit, irrespective of whether the unit is at the station or elsewhere. Death report.

30. Officers commanding field hospitals will, in future, when sending in Army Form A 6, be careful to state, in case of gunshot wounds (except those of abdomen), whether or not there has been injury to bone. Gun-shot wound, injury to bone.

Extract from Army Orders:—

31. Several cases having occurred in which men first reported killed or missing, and afterwards found, have not been so reported. Officers commanding units are held responsible that the rejoining of such men is immediately reported by telegraph to the A.A.G., Army Headquarters, Cape Town, for transmission to the Secretary of State for War. Casualties.

Officers commanding field, stationary, or general hospitals, are held responsible that men who have been returned as wounded, and afterwards die of wounds are reported to the officer commanding their unit, and to the A.A.G., Army Headquarters, Cape Town.

32. Officers commanding field hospitals will be careful to note in admission and discharge book those cases of enteric fever in which inoculation has been performed. Inoculation for enteric fever.

33. In future the deaths of all officers, which may occur actually in the division, are to be reported to the Chief of Staff immediately. Deaths of officers.

The communication is to be marked in top left-hand corner, "Casualty."

IV.—*Sanitary.*

Extract from Army Orders, South Africa, dated February 21, 1900:—

34. "The attention of general officers commanding divisions and brigade, and officers commanding regiments, battalions, and other units, is again invited to the necessity of exercising more supervision over the discipline, sanitation, and regularity of their bivouacs. On arrival at a bivouac each unit should occupy its allotted space; latrine should be dug, places for cooking, depositing rubbish, transport, officers' and other horses, &c., established, and no other places permitted to be used for such purpose. The greatest care Sanitation, &c.

should also be taken to prevent the fouling of the water supply, and to allot places for drawing drinking water and watering animals.

"Offal must be buried and dead horses and other animals removed from the vicinity of camp, cut open, and, if possible, buried.

"The messing of the men should be conducted with as much regularity as practicable, under the supervision of the officers, who will similarly exert themselves in looking after the comfort and cleanliness of their men, and in ensuring that they should suffer as little as possible from the heat by day and the cold by night; much may be done in this direction by the exercise of a little ingenuity. Similarly during stay in a bivouac, daily fatigues and inspections should be provided for as would be done in a standing camp, and every care must be taken to keep the surroundings in as sanitary a condition as possible."

Refuse to be burnt and buried.

35. Extract from D.O., dated April 21, 1900:—

"All tins, empty bottles, &c., are to be collected and placed in heaps or buried; all old sackings and rags are to be burnt, and not to be thrown on manure heaps as has frequently been the case hitherto."

Sanitary condition.

36. The attention of officers in charge regimental and field medical units is directed to the necessity of maintaining the utmost vigilance as regards the sanitary conditions of their camps and vicinity thereof. An ample supply of disinfectants is available, which should be freely utilised. Their attention is directed to Section VII. and Appendix V., Medical Arrangements for South Africa, issued from the War Office, October 31, 1899.

Washing with soap.

37. All washing with soap in dams in the neighbourhood of camps where animals are watered is strictly forbidden. If soap is used, it must be used at a distance from the banks, the water being fetched in buckets from the dam.

Cleaning of water carts and utensils.

38. The attention of regimental commanding officers and medical officers is called to the necessity of seeing that the water carts and cooking utensils of their units are kept thoroughly clean. When washing out the former, which ought to be done at least twice a week, some disinfectant, such as permanganate of potash, should be used.

Quicklime for latrines, &c.

39. With reference to D.O. No. 8, dated 30th ult., all latrines, urine buckets, soakage pits, &c., and ground in vicinity, should be freely treated with quick-lime.

V.—*General.*

Rations.

40. On the order being given to proceed on the line of march, two days' biscuits and two days' grocery ration will be carried in the haversack.

Supplies to patients.

41. Officers commanding field hospitals will report to the brigade authorities any neglect to supply rations and blankets for men admitted to hospital.

Patients' valuables.

42. Extract from D.O., No. 1, dated May 1, 1900:—

"As there is no provisions in field hospitals for safeguarding money, valuables, &c., taken by men to hospital, officers commanding are to arrange that all articles of this nature be left in charge of the regiment to which the sick man belongs, and that a receipt be given to the man for articles taken over from him."

Arms and equipment of sick.

43. Extract from D.O., dated May 8, 1900:—

"With reference to Army Order No. 1 of April 27, 1900, the arms, accoutrements and ammunition of men who die in hospitals at Bloemfontein, or who are invalids to the base at Cape Town, will be handed over to the Ordnance Officer, Bloemfontein. The Ordnance Officer will arrange, as opportunity offers, to forward the arms and equipment to Cape Town, with a view to re-issue to men who may recover or become available for duty and to drafts from England, which will in future arrive unarmed.

"The ammunition will be returned for issue on the spot."

Poisoning of water.

44. The following memo., published by Field-Marshal Lord Roberts, is circulated for information:—

"The Field-Marshal has drawn attention to the possibility of poisoning of the wells in the enemy's country by cyanide of potassium, and directed that the danger be kept in mind by medical officers of the Army.

Appendix XI.

AMBULANT TYPHOID BEFORE COMING TO HOSPITAL

IRISH HOSPITAL
PRETORIA.

CHART I.

(Dr. Coleman)

DISEASE

Enteric Fever

(Not inoculated)

Notes of Case

Name Woodford Pte. 2nd Wilts.

Age 21

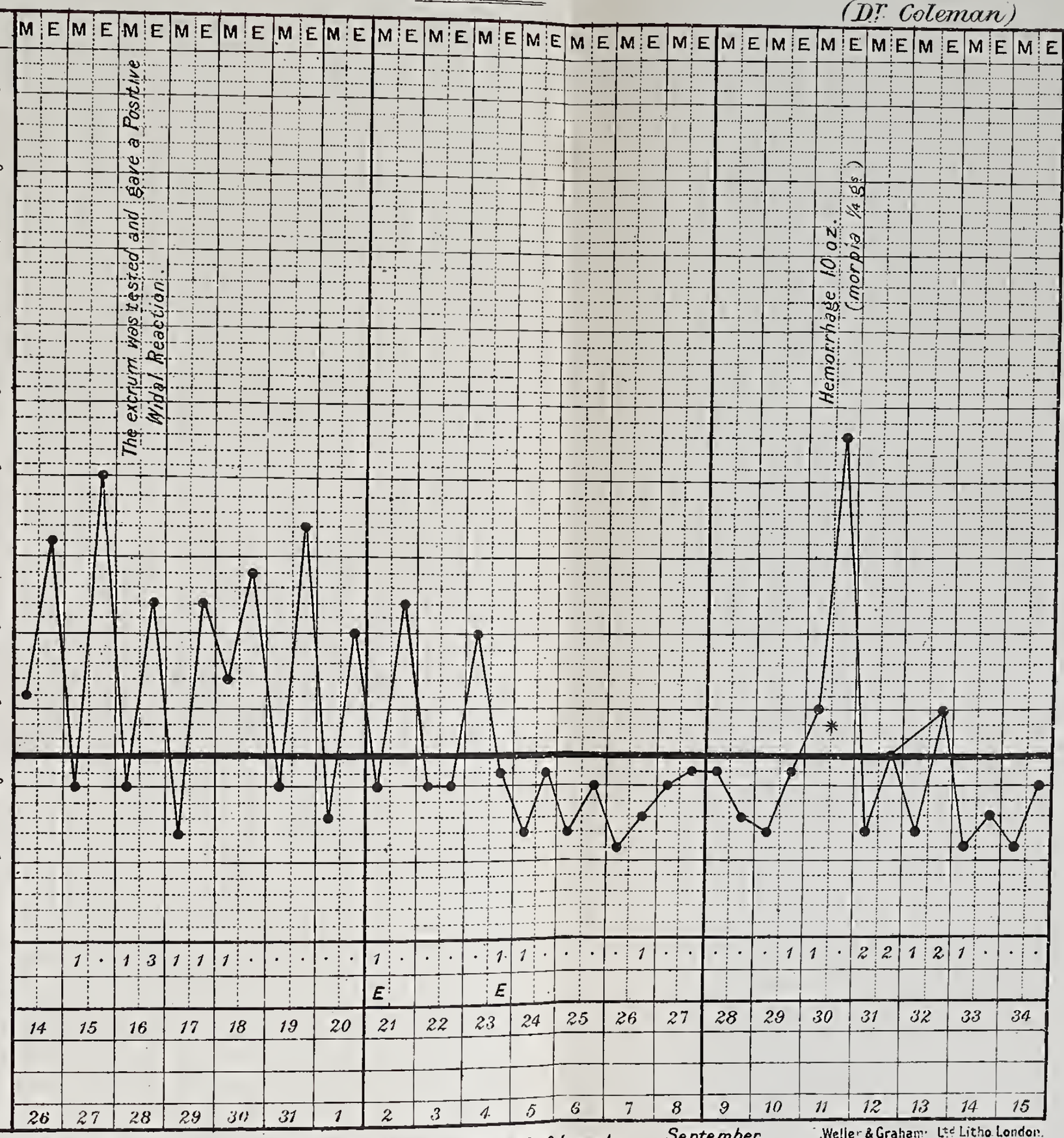
No. 5338.

Case Book No.

Admitted complaining of sore throat, headache and fever.
Has been ill about a fortnight but only went sick 2 days ago.
The attack began with headache & diarrhoea the latter lasting about a week.
Inoculation. was not.
Previous History:- Had Rheumatic Fever in 1892.
Examination:
Tongue, coated with white fur and centre edges and tip clean.
Abdomen, distended.
Spleen, palpable and tender.
Enteric Spots, present.

Date of admission

26th August '00.



1930.1.02

Weller & Graham Ltd Litho London.

* 12.9.00. Patient admits having eaten about half a loaf of bread on 10th which he begged from a convalescent patient.

Appendix XII.

CHART II.

IRISH HOSPITAL
PRETORIA.

(Dr Coleman)

DISEASE

Enteric.

Notes of Case

Name { *Pte. W. Smith*
2nd Norfolks.

Age 20

Diet

No. 5146.

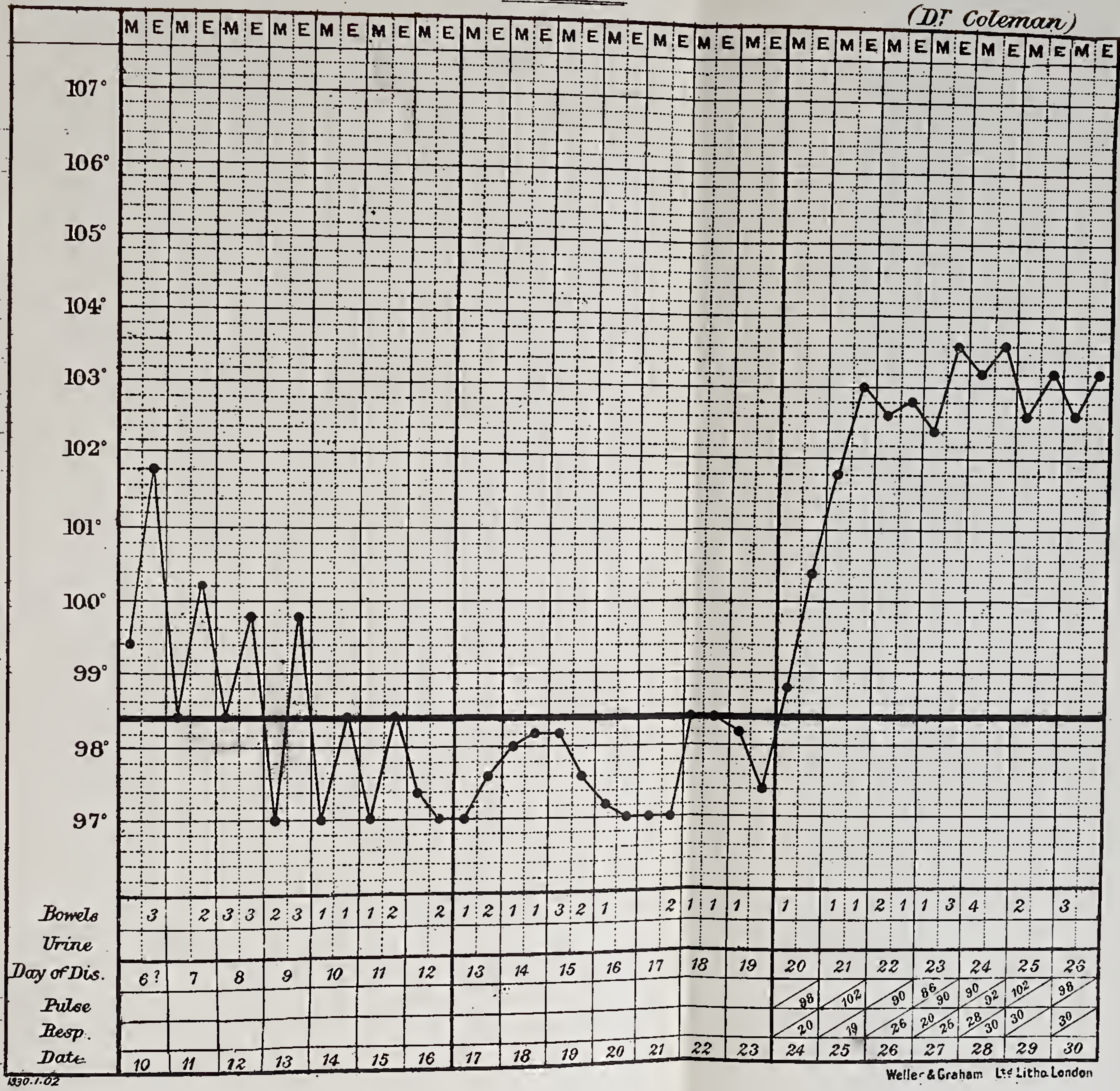
C. of E.

Sent in as a case, of dysentery was complaining of headache & diarrhoea, anotexia and weakness for 3 weeks.

Exam. No particularising signs.

24.IX.00. Enteric, evidently relapse.
Congestion of bases of lungs, most marked in left.

Date of admission
20th September '00.



IRISH HOSPITAL
PRETORIA.

(Dr Coleman)

DISEASE

Notes of Case

Name { W. Smith

Age

Diet

Case Book N°

8/10/00
Pulse intermits 3 or 4 beats per minute.

Patient died at 12.15 p.m.

He was sleeping quietly when got a sudden attack of bloody nose, dying inside 15 minutes.

	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E	M	E
Bowels		1	1		2	2	1	1	1		3	1	1		3	2	2	2	1	1		1	3	1	2	2														
Urine																																								
Day of Dis.	27		28		29		30		31		32		33		34		35		36		37		38		39		40		41		42		43		44		45		46		47
Pulse	100	108	98		104	116	103		104	118	110	116	116		100	102		118	90	104	90				106	104													
Resp.	36	39	38		38	28	32		28		24	26	30		30	28			28	26	26				26	24													
Date	1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21

Date of admission

1830.1.02

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"Cyanide of potassium renders water alkaline; in cases of suspected water, its condition in this respect should be tested by the usual means of turmeric or pink litmus papers, before using it for drinking purposes."

45. Extract from D.O., dated March 22, 1900 :— Cutting of trees.

"It is forbidden to cut trees or shrubs within 200 yards of the field hospitals, these being required to shelter patients in the day time."

46. The passes of all vendors of ginger ale, &c., in camps should be called in, and only re-issued when the medical officer of the battalion or unit is satisfied that the manufacture of these aërated waters is above snspicion. Vendors' passes.

The premises of the vendor should also be inspected.

47. Officers commanding field medical units, and officers in charge regimental units, will be careful not to admit civilians into their lines, or afford any official information without special authority from Principal Medical Officer, Army, Principal Medical Officer, Bloemfontein, or other competent military authority. Civilians, admission to camps.

48. Extract from D.O. No. 8, dated May 29, 1900 :— Effects of men dying on service

"Pocket ledgers of all deceased soldiers are to be forwarded to the War Office at once. If the pocket ledgers have been lost, a statement as to any will or distribution of effects on Army Form B 2090, or on a separate paper, will be forwarded instead."

The foregoing orders are re-published by direction of general officer commanding division, and are issued for the guidance of all concerned.

W. L. GUBBINS, M.B.,
Lieut.-Colonel,
Principal Medical Officer, 6th Division.

Bloemfontein, *June* 1, 1900.

APPENDIX XIII.

[Copy.]

The Military Governor, Pretoria.

Racecourse Hospital.

Sir, *August* 29, 1900.

On Saturday I accompanied Colonel Maxwell on a visit of inspection to the Racecourse Hospital. As the building is to be used for some time yet for 50 beds it became necessary to devise means to dispose of the sewage. We are agreed that this can most safely and economically be effected by means of a drain discharging about 200 yards from the building, where the water can be used to irrigate the gum trees.

You may remember my remarks with regard to the advisability for making sanitary inspection of camps as well as of hospitals. The truth of these remarks was very strongly confirmed by our observations on Saturday afternoon. Some hundreds of men, mostly belonging to the West York Regiment, had just been camped on the Racecourse, the site selected being just below the outfall of the hospital drain. Some of the soldiers were actually washing themselves in water flowing from the drain. There can have been no reason why these men should have been placed in such an unfortunate position. On both sides there was ample space for them to have camped without them going beyond the boundary of the Racecourse. It has been the endeavour of the Medical Officer in charge of the hospital to exclude, as far as possible, all typhoid excreta, and the water used for washing linen soiled by typhoid patients from this drain, and to dispose of them separately after disinfection, but it is evident that no one can be certain that this drainage may not nevertheless be occasionally polluted. Again, on Tuesday, when I went to inspect the railway station, I noticed that the men were allowed to lie about, cook, and eat their food upon and around the refuse heaps within a few feet of the foul latrines which are soon to be removed. It is impossible to expect to prevent the occurrence of enteric amongst the troops if the most elementary precautions are thus disregarded.

I can quite understand that officers have great difficulty in preventing excremental pollution when the men arrive tired out at a temporary bivouac.

Should it be intended, as I suppose it is, to use the Racecourse as a place on which troops passing through the town can camp while waiting for transport, we must provide proper privy accommodation for them, otherwise the ground will soon be dangerously fouled.

I would suggest, and I put this forward merely as a suggestion, because I am not sufficiently acquainted with military matters to know if it is practicable, that places intended to be used as temporary camps should be fixed upon, and that an officer of Engineers and a medical officer should fix upon the places where the men should relieve nature and where the tents must be pitched.

Perhaps even other preparations might be made, such as the storage of fuel, &c., so that the men might have warm food and drink as speedily as possible.

The recovery or otherwise of men infected with typhoid fever may frequently depend upon the avoidance of unnecessary exertion at the commencement of the attack before the symptoms of the disease are sufficiently developed to oblige the men to seek medical advice.

I am, &c.,

(Signed) GEORGE TURNER, *M.O.H.*,
Transvaal.

APPENDIX XIV.

[Copy.]

The Military Governor, Pretoria.

Sir, *September* 28, 1900.

In accordance with the communication I made to you concerning the water supply at the railway station, on the 26th, I saw Colonel Maxwell, and together we visited the station.

We could not at the time discover anything definite as to the distribution of the water, further than that there appeared to be two separate sources of supply, one from the waterworks and the other from the sluit.

I then learned for the first time that a rest camp had been formed close to the station on the side more remote from the town and under the hill. This camp, we were informed, was supplied by tanks upon the hill, and these tanks it was supposed were filled during the night from the town main. I did not feel at all satisfied as to the possibility of water from the mains reaching the tanks, even in the night when the pressure is at the highest. So I wrote to Mr. Karlson to make enquiries.

I received the enclosed reply which I immediately communicated to Colonel Maxwell and Captain Fuller.

On the afternoon of the 27th I met Colonel Maxwell, Captain Fuller, Mr. Karlson, and Mr. Uggla, the late engineer of the railway, and others. We then found that only one tap on the railway station was supplied with drinkable water, all the others took their water from the sluit. The tanks on the hill, too, were filled from the station.

Colonel Maxwell and I consider the matter so urgent that Colonel Maxwell decided at once to put up two 600-gallon tanks to supply the station with drinkable water.

The tanks will fill during the night, and a spring tap will be provided to prevent waste. The same tanks will supply the rest camp.

The tap at present most in use is outside the station garden, this is supposed to be for horses and cattle only, but that it is not used for drinking is more than doubtful. We have decided to remove the tap altogether, the animals can quite well go to the spruit which is within a few yards.

As many taps as possible will be abolished in order to prevent men from using bad water. Unfortunately there is one danger which cannot be avoided. The Royal Engineers have just finished the construction of some very excellent latrines and lavatories, our supply of pure water is so short, owing to want of pressure, that the taps of this lavatory must be served by the station cisterns, and there is always danger that men will drink the bad water.

However, a supply of pure water will be provided quite close to this place, and a caution will be put up in the lavatory against drinking water from the taps there.

I trust that our action in this matter will meet with your approval.

Incidentally, I wish to call your attention to a danger which I have pointed out before. The existence of this rest camp only came to my knowledge quite accidentally. I was with Colonel Maxwell, and as he was moving the old latrines from the station to the camp he went to inspect it and I accompanied him. Naturally I made enquiry as to the water used there, and those enquiries led to the discovery that the water was dangerous. Had the existence of the camp not come to my knowledge in this way, soldiers arriving and staying for a night or two would very probably have been infected, they would perhaps have removed to places which we had taken pains to provide with good water and the fever subsequently developing we should have had much trouble and difficulty in discovering its origin.

I am persuaded that no permanent camp such as this rest camp should be established until the water supply and other sanitary arrangements have been most carefully considered. Men arriving tired and thirsty from a journey are sure to drink, and often to drink immoderately of water and they are then especially liable to be infected with enteric fever.

In active service it is practically impossible to prevent the consumption of doubtful water, but that is no reason why, where possible, the danger should not be guarded against.

I am, &c.,

(Signed) GEORGE TURNER, *M.O.H.*,
Transvaal.

[Copy.]

The Military Governor, Pretoria.

Sir, *September* 26, 1900.

I have seen Mr. Karlson with regard to the water supplied to soldiers at the railway station.

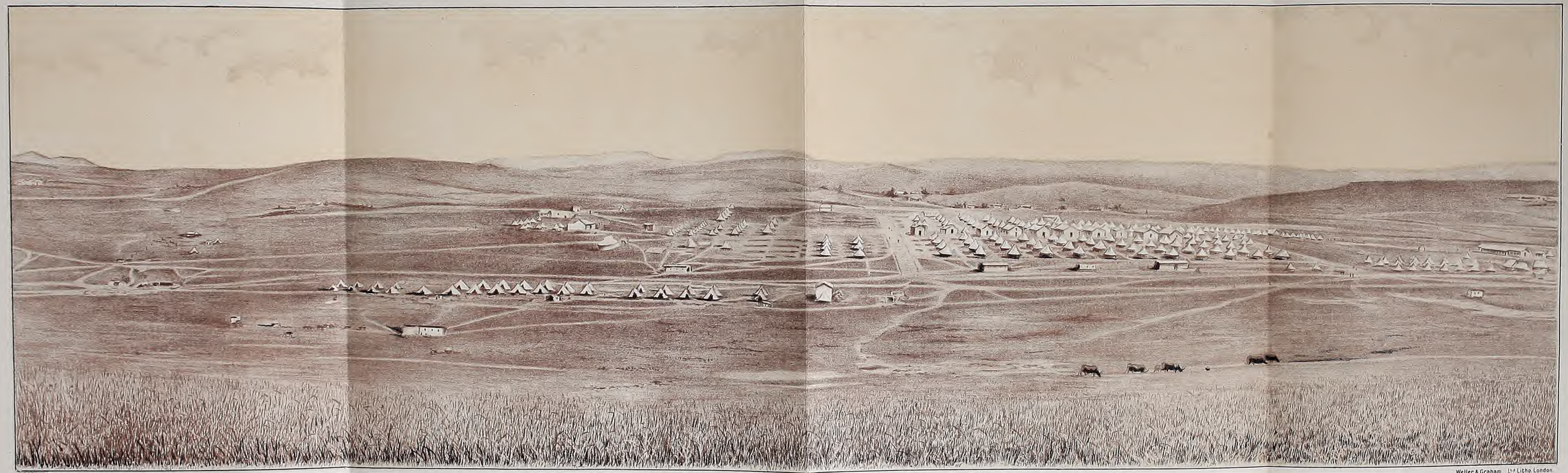
I find that there is not sufficient pressure to put up a stand-pipe for the men to drink from, and the supply must be from a tank which can be filled from the main at night when the pressure is better.

At least a 600 gallon tank should be put up and a tap fixed to it of a kind which must be held while water is drawn off to prevent waste. Shall I see to this?

I am, &c.,

(Signed) GEORGE TURNER, *M.O.H.*,
Transvaal.

APPENDIX XV.



1930. S. 02.

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No. 4, GENERAL HOSPITAL, MOOI RIVER.

1930-5 02.

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No. 9. GENERAL HOSPITAL, BLOEMFONTEIN.

PART III.

REPORT ON THE CAUSATION AND PREVENTION OF DYSENTERY, &c.

By Colonel J. Lane Notter, M.A., M.D., D.P.H., R.A.M.C.

A Commission was appointed by the Secretary of State for War, on August 8, 1900, to "inquire into the nature, causation, pathology, and modes of prevention (more particularly as affecting armies in the field) of dysentery, and its connection, if any, with enteric fever."

Two members of the Commission (Colonel J. Lane Notter and Dr. W. J. Simpson) left England for South Africa on August 18, 1900, and on arrival at Capetown, on September 4, they were joined by Lieut.-Colonel D. Bruce, the third member appointed to it.

The routine adopted by us on arrival at Capetown is set forth in the "Introduction" of the report submitted by Dr. Simpson, and the Commission prosecuted its labours until the middle of February, 1901, when Dr. W. J. Simpson left for Cape Colony, and the work of the Commission from that time practically ceased.

I remained on at Headquarters until the middle of October, 1901, and acted as sanitary officer, visiting many camps and stations, and reporting the results of my inspections to the Principal Medical Officer at Headquarters. This arrangement was, I believe, satisfactory, and many improvements I suggested in these reports were at once carried out.

It is regretted that the Commission was broken up before they completed the inspection of many camps and stations which they had arranged to visit together, and which would have afforded them information for discussion that would have been of value in formulating their report.

Many chapters in Dr. Simpson's report are devoted to events which took place long before the Commission arrived in South Africa; they were not the result of personal observations, and I am inclined to believe that in some cases they are the outcome of personal narratives, and are not sufficiently precise to enable us to form any true estimate of the conditions existing at the time. I am decidedly of opinion that only such facts as came under the notice of the Commission, during their investigations in South Africa, should alone form the basis of their report, and holding to that opinion I do not commit myself to the accuracy, or otherwise, of events which took place long anterior to the date of our arrival, and which are even now questioned by others outside the military service.

In attempting to form an opinion as to the causes of the successive prevalence of enteric fever and dysentery among our troops in South Africa, it is necessary to note the facts in respect of the following points :—

1. The general endemic prevalence of this class of disease in South Africa before the War.
2. The age constitution of our forces.
3. The composition of the Army.
4. Flies as carriers of disease.
5. Liability of Kaffirs to dysentery.
6. Food supplies.
7. Water supplies.
8. Milk supplies.
9. Disposal of excreta.
10. Soil pollution.
11. Density of population in camps and personal infection.
12. Present state of our knowledge regarding Etiology of Enteric Fever and Dysentery.

1. General endemic prevalence of these diseases in South Africa.

The seasonal prevalence of dysentery and enteric fever in South Africa is from the end of November to early in May, but only a few cases of the former disease occur before January. It is thus seen that during the greater part of the time the Commission was actually in existence these diseases were more or less quiescent, or at least at their minimum. I had, however, later on ample opportunity for studying some of the incidents connected with their prevalence and possible causation.

2. Influence of age.

During my inspections I was early impressed with the youth of the Army. I have no means of stating the actual average age of the troops employed, but that the divisions and brigades were very largely composed of young men is beyond doubt. Few appeared to be over 25 years of age, and a large number were considerably under it. No doubt many men in their anxiety to join the active Army understated their age, but this could not account for the large numbers of young men in the ranks.

The conditions which produce dysentery in armies are akin to those which cause enteric fever, and although these diseases are different, yet I cannot but think there is a causal relationship existing in their dissemination.

Murchison gives 52 per cent. of his cases of enteric fever among individuals from 15 to 25 years of age, and Fiedler found 59 per cent. of his cases to range between 20 to 30 years of age. The predisposition of this disease at an early age may partly be accounted for by the acquired immunity conferred on older men by a previous attack, and the nature of which they were possibly ignorant of.

But if we may draw any conclusions from the sickness and mortality of the Army in India, we shall find that there is an even more important factor than age as a predisposing cause.

Enteric fever most frequently attacks *new* arrivals in that country, and that it is especially the newly-arrived soldier who suffers from enteric fever is made evident from the following table :—

TABLE showing the Average Annual Admissions and Deaths from Enteric Fever in British Soldiers in India in 1899.

Length of Service in India.	Average Strength.	Admissions.	Deaths.	Ratio per 1,000 of Strength.	
				Admissions.	Deaths.
Under 1 year	12,028	621	138	51·6	11·47
1 to 2 years	12,191	369	94	30·3	7·71
2 „ 3 „	10,735	124	33	11·6	3·07
3 „ 4 „	9,481	101	29	10·7	3·06
4 „ 5 „	8,157	67	20	8·2	2·45
5 „ 10 years	11,397	100	34	8·8	2·98
10 years and over	2,226	..	..	..	..
Not stated	1,482	10	..	6·7	..
Total	67,697	1,392	348	..	5·14

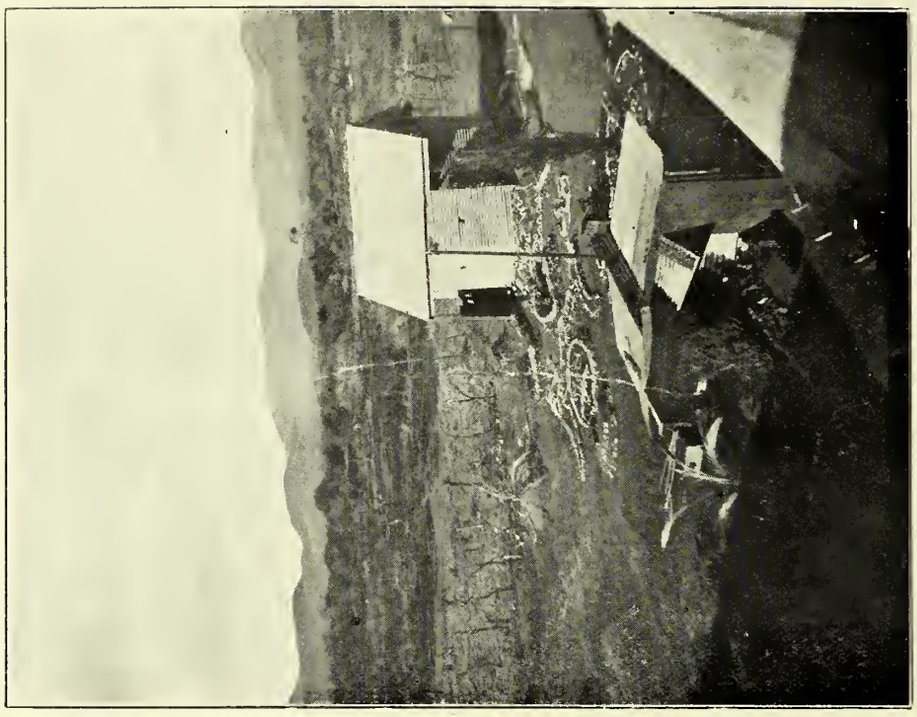
It is impossible at present to give a comparative table for South Africa, but personal observation and inquiry goes to show that a certain protection is acquired by acclimatisation. The great increase and prevalence of enteric fever and dysentery was dependent on an enormous increase in the number of *young and recently-arrived* soldiers which were suddenly brought together through the exigencies of war.

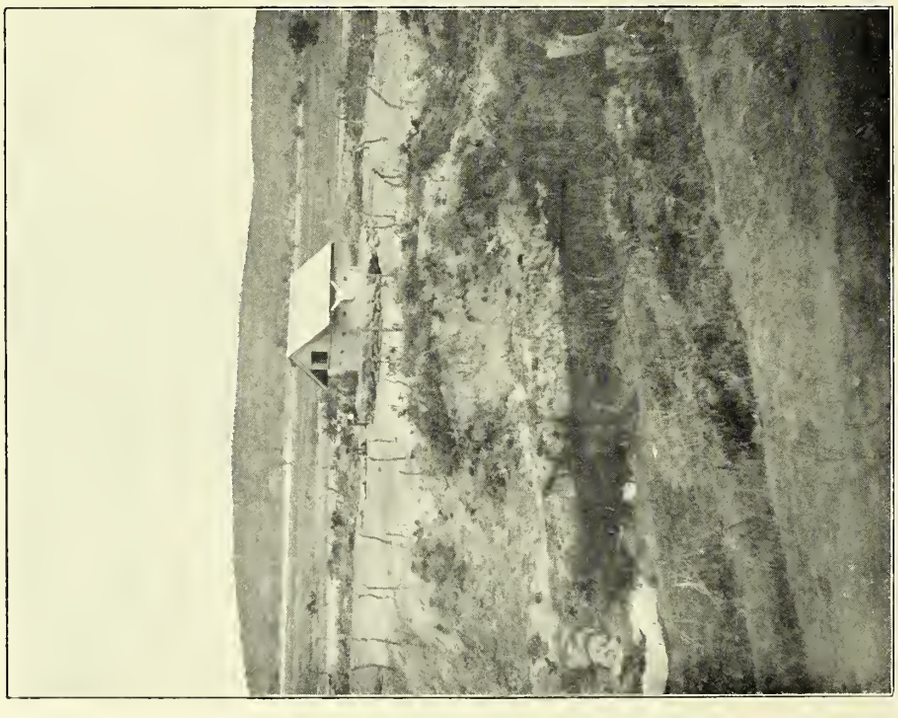
3. The composition of the Army.

In no previous wars has the composition of the Army been the same as in the present war. Owing to the nature of the country, character, and mode of life of the Boers during peace, and their training by their commanders, it was absolutely necessary to employ large bodies of mounted troops, out of all proportions to the numbers that compose an Army Corps as it then and now exists.

The absence of food supplies for men and animals throughout the vast areas traversed by these mounted columns in the Transvaal and Orange River

[*To face page* 133.





BLOCKHOUSES ON THE NORTHERN LINE.

Colony necessitated huge convoys of Kaffirs and ox wagons to accompany the men.

In a country so exposed, and with an enemy so agile, it was necessary to form camps on the line of march in close formation.

4. Flies as carriers of disease.

These circumscribed camps involved the presence of large numbers of animals in close proximity to the men, and with the animals came myriads of flies, which were not only a pest, but were, I believe, one of the chief means of spreading these diseases—both dysentery and enteric fever.

I was very forcibly impressed with this fact in February, 1901. At Kroonstad, during the latter part of the year 1900 and January, 1901, there were comparatively few cases of enteric fever; then there was a perfect plague of flies, lasting for about 10 days. No one could say why they so very suddenly increased, and almost as rapidly disappeared, but their advent was followed by a very sharp recrudescence of enteric fever. The late Colonel O. G. Wood, C.B., told me that it was the second time he had noticed this fact.

Flies can carry enteric infected matter from specific excreta, or other polluted material, and deposit it on the food of the men. Such infective matter appears to be attached not only to their heads, but also to their legs, wings and bodies.

I have seen in Bloemfontein and Pretoria, where the pail system for the removal of excreta is the one in use, swarms of flies passing between houses and rooms and the latrines, which are in close proximity.

In temporary camps, occupied only for a few days, these conditions, and the serious danger attaching to them, were less evident.

I am satisfied that there is some evidence to show beyond any doubt that the active agents in the dissemination of enteric fever in standing camps were flies.

In the blockhouses where there were only a few men, and where there were no conditions present to attract flies, the men suffered less from enteric fever, while those living in camp where flies could pass from fæcally-infested matter in latrines to food in tents, or in the open, enteric fever was more prevalent. These photographs will convey an idea of what these blockhouses were, and how situated.

The late Dr. J. W. Washbourn, C.M.G., insisted that this disease was conveyed by flies and dust. I had frequent opportunities of discussing the subject with him and he never hesitated to express very forcibly his opinion on this point.

It may also be noted in connection with this point that enteric fever practically ceases with the onset of the cold weather and its advent reduces the number of flies, so that with the cold and frosty nights flies disappeared and with this the decrease in the number of enteric cases occurred.

5. Liability of Kaffirs to dysentery.

I have alluded to the large number of Kaffirs who were employed with the Army. They suffered from dysentery to a great extent—I have seen many cases and the difficulty of dealing with these people is beyond expression. When slightly affected they remain with the troops, and it is often only by accident that they acknowledge being sick. If they are unable to work they very frequently disappear to their kraals. It is with the greatest difficulty that they can be induced to use a latrine and no matter what precautions are taken they will evade them. They are filthy in their habits and will eat almost any kind of food. They are particularly fond of meat and the entrails of animals; there is, therefore, the danger, always present, of the transference of dysentery from them to the troops.

I did not meet with many cases of enteric fever among these men, but dysentery was exceedingly common; I believe it was chiefly due to the large quantities of meat they consumed, which was often more or less decomposed.

Animals that had died from exhaustion or fatigue they would eat readily.

6. Food supplies.

The food supplies for an Army in the field is a very difficult problem.

In the present war no effort was spared to supply the troops, and the success was phenomenal. Never has an Army, so far removed from its base, with limited means of transport and operating over so large an area, been so well looked after as regards its food supplies; but there are circumstances outside the best and most complete system which will influence the health of the men.

To take a concrete example. A body of young men are sent out from England and are suddenly thrown on the veldt, without any of the experiences of the old and trained soldier. In place of their ordinary food they subsist on tinned meat and biscuit—of vegetables there are none, but jam is provided instead. The result of such a diet after a few days, coupled with fatigue and the difficulties incidental to marching and possibly neglect, induces constipation which passes off with a mild attack of diarrhœa or in the less robust produces enteritis. When the latter follows it may perhaps be due to the use of tinned meat.

I had personal experience of this fact. Three of us partook of some tinned meat which we thought excellent; about 4 hours after our meal we all suffered from diarrhœa. Two escaped with no further effect, but dysentery followed in my case and I was in hospital with an acute attack for some weeks —I have no doubt but that such cases are more frequent than happen to be recorded and I do not know how they are to be avoided.

The same results I have known to follow on eating the meat from over-driven and exhausted animals.

Septicæmia may be produced by constipation following on an ill-arranged diet—I believe I have seen instances of this. The effect produced closely resembles enteric fever in its early stages, but the febrile attack passes off and the patient is convalescent in 8 or 10 days; it is probably a form of coli poisoning.

7. Water supplies.

The dissemination of dysentery and enteric fever by means of impure water is beyond question; the evidence in its favour is overwhelming and decisive. In sterilised distilled water, when kept at ordinary room temperatures and in the dark, the enteric bacillus may retain its vitality for 3 months, but where exposed in shallow vessels to the direct sunlight the destruction of the bacilli are almost insured.

The chemical composition of ordinary water largely influences the growth and multiplication of the bacilli, the presence of nitrites and nitrates in particular being necessary to further the multiplication and growth of the organism. The absence of these constituents in the surface water—which was the supply mostly used by the troops on the march and in temporary camps

away from the larger towns—and which was drawn from shallow spruits, exposed to the direct rays of a semi-tropical sun would lead one to suggest for the reasons given above that other causes besides water were possibly prevalent, and acted equally, as a factor in disseminating these diseases.

In towns such as Bloemfontein and Kroonstad, supplied by water from impure sources, there can be no doubt that it was one of the chief agents that caused the endemnicity of the epidemic ; but for the column on the march or those in other places that were dependent on surface supplies the same conditions could not be said to exist.

At Bloemfontein the water supply is taken from the Orange River which near the intake has a dam thrown across, over which the surplus water flows. The waterworks are situated 21 miles from the town, and, after passing through filter beds the water is pumped to a reservoir on Bushman's Kop, from where it is distributed to the town reservoir by gravitation. The river from which the supply is taken is absolutely unprotected. Kaffir kraals are situated at varying distances along its banks and paths lead from them to the river. Anyone acquainted with the habits of Kaffirs can easily understand how pollution occurs and how impossible in many cases it is to guard against it.

The filter beds were filled with a coarse "kunker" soil—there was no sand available nor was there any attempt for a surface membrane or layer to form on this filter. The result was purely mechanical filtration and even this was incomplete ; the vital action of a properly-constructed filter bed was altogether wanting, and what was aimed at appeared to be the clarification of the impure and muddy water of the Orange River. I much regret I was unable to make an analysis of this water at the time.

Bloemfontein does not appear to have suffered greatly from enteric fever *before* the introduction of the present water supply. The numbers, so far as I could learn, who were attacked were few. According to the "Mayor's Minute" for the year ending August 31, 1889, only one death from enteric fever in each of the years 1885, 1887 and 1889 occurred in the town, and in 1884 and in 1886 not a single death was registered for this disease.

Dr. Stollreither, who was the chief medical officer, told me that in 1883 and 1884 there was no enteric fever. In 1885 a few cases were imported from Kimberley, in 1886 there were no cases, in 1887 and 1888 a few slight cases appeared. In November and December, 1889, and in January, 1900, came an influx of people to work on the railway and from that time the town has never been altogether free from the disease.

The following table gives the deaths in each year from 1895 to 1900 :—

Years.	Number of Deaths.
1895–96	29
1896–97	23
1897–98	25
1898–99	11
1899–1900	22

It is evident, therefore, that the introduction of water from the Orange River *in* 1899 increased rather than it diminished the liability to this disease.

The Contract with the Bloemfontein Water Company was made on December 24, 1889, and Clause 6 of the Contract stated "that the water-works shall be completed within 3 calendar years from that date." In July, 1892, it was reported to the Town Council "that the works had not begun;" they were, I believe, opened late in 1898, or the beginning of 1899.

Dr. Stollreither said that, in March, 1894, he could speak of enteric fever as being epidemic for the first time—and there was a very severe epidemic in 1896 and 1897. Previous to March, 1894, only sporadic cases occurred.

On May 19, 1900, Dr. Howard H. Tooth, M.A., M.D., F.R.C.P., reported on the water supply as follows :—

1.	Colour in 6-inch column ...	Distinct yellow tinge.
	Turbidity	Very considerable and increased on boiling.
2.	Odour	None.
3.	Residue left on evaporation ...	Very small, yellowish white, very slight charring on heating, no smell, dissolves with evanescence with acids.
4.	Free ammonia	None.
5.	Chlorine	2 grains per gallon.
6.	Nitrites	A very considerable quantity.
7.	Nitrates	?
8.	Hardness	Somewhat over 4°
9.	Lead	None.
10.	Zinc, iron, copper	Distinct trace of iron.
11.	Oxygen absorbed in 15 minutes at 212° F.	Between ·20 and ·30 with brown discolouration.

" From the examination of the water herein referred to, and the results obtained by analysis, I am of opinion that it should be regarded with great suspicion for drinking purposes."

In the above analysis it is evident that Dr. Tooth had not the means at his disposal to make a quantitative estimation of either the free or albuminoid ammonia. Nevertheless, the presence of nitrites in considerable quantity, and the high chlorine, gave indication that the water was bad, and had he been able to distil over the free ammonia, he doubtless would have found it present.

The absence of nitrates indicates arrested oxidation ; the oxygen absorbed would have been larger if the sample of water had not been heated to the boiling point, but kept at 140° F., as is usually done.

At Kroonstad the water was pumped from the Valse River, just above the town. It cannot be said to have been subjected to any proper system of filtration before distribution, as the filtered water was not free from sedimentous matters, and contained very many diatoms, which passed through the so-called filter bed. The river received the sewage of Lindley and other towns and kraals situated on its banks. I made analyses of this water, and found it was polluted with sewage matters.

The water was very turbid, and gave a distinct ammoniacal smell when kept for some days in a closed bottle. After our occupation, trial borings were made in many places, but with only partial success. At 200 and 400 feet no water could be found. Fortunately, three borings gave a sufficient supply for drinking purposes, for the hospital and for the troops in camps outside the town.

The supply of potable water for Kroonstad and other towns in South Africa is an exceedingly difficult problem. The Royal Engineers had diamond drills at work for many months at Kroonstad, and they spared neither labour nor money in their efforts to obtain a supply of good water for the troops.

In Pretoria we were exceedingly fortunate in finding a pure and abundant water supply. The source is from springs, along the sides of a high mountain, where dolomite cropped out, and which was the only place in the district in which this stratum was seen.

There is a constant flow of very pure water, which is impounded in a reservoir sufficiently elevated to allow of the town being supplied by gravitation. The Boer Government wisely held the collecting area in their own hands, so their is little fear of contamination. I made nine analyses of this water. The results are as follows :—

Analyses of Samples of Water from Pretoria Waterworks.

Number.	Organisms per Cubic Centimetre.	Solids in Grains per Gallon.	Chlorine in Grains per Gallon.	Ammonia.		N_2O_3.	N_2O_5.	Oxygen absorbed at 80° C.		Remarks.
				Free.	Albuminoid.			After 15 Minutes.	After 4 Hours.	
1	130	13·0	0·05	0·0	0·0	0·0	0·128	0·0	0·0	Except where stated, the results are given in parts per 100,000. No coli were found in any of the samples.
2	109	12·9	0·05	0·0	0·0002	0·0	0·120	0·0	0·0	
3	142	12·8	0·05	0·0	0·0	0·0	0·124	0·0	0·0	
4	126	12·8	0·05	0·0	0·0004	0·0	0·120	0·0	0·0	
5	136	13·0	0·05	0·0	0·0	0·0	0·128	0·0	0·0	
6	116	12·9	0·05	0·0	0·0	0·0	0·128	0·0	0·0	
7	139	13·0	0·04	0·0	0·0004	0·0	0·122	0·0	0·0	
8	122	12·8	0·05	0·0	0·0	0·0	0·128	0·0	0·0	
9	140	12·9	0·05	0·0	0·0	0·0	0·128	0·0	0·0	
No. 2 General Hospital ..	200	13·2	0·05	0·0	0·0	0·0	0·130	0·0	0·0	

I examined the water from several shallow wells which supplied the camps outside Pretoria, and which could not be connected at once with the town supply.

The springs yielded such a large supply that fresh water was constantly passing through the surface wells.

The following is an analysis of a sample of water taken from a spring near Diamond Spruit, and used by the Hampshire Regiment. The water was turbid, but the sediment settled down very rapidly. The deposit consisted of fine yellow clay, which recent rain the night before had brought down. The water was pumped into water carts and boiled before being distributed.

Solids	9·00 grains per gallon.
Chlorine	0·3 „ „
Free ammonia...	Nil.
Albuminoid ammonia ...	0·001 parts per 100,000.
N_2O_3	Nil.
N_2O_5	0·098 parts per 100,000.

No coli present after 24 hours.—4/12/00.

The following is an analysis of a sample of water taken in a sterilised bottle at Quagga Fort on December 1, 1900. The water is pumped from a well about 500 feet below the fort. The well is sunk in the valley to a depth of about 110 feet. There is no very large yield, as excess of pumping soon exhausts the well. The water is received in the fort into five tanks, containing 400 gallons each, and the sample was drawn direct from one of these tanks.

The physical characters noted were :—

Clear	Very small sediment (clay).
Slightly yellow colour ...	No smell.
Solids	6·0 grains per gallon.
Chlorine	Very slight trace.
Free ammonia...	Nil.
Albuminoid ammonia... ...	0·003 parts per 100,000.
N_2O_3	Nil.
N_2O_5	0·06. „ „

No coli or other growths after 48 hours.

The analysis of the water supply to West Fort, Pretoria, on October 8, 1900, gave the following results :—

Total solids	19·25 grains per gallon.
Chlorine	0·07 „ „
Free ammonia...	Nil.
Albuminoid ammonia... ...	0·006 parts per 100,000.
N_2O_3	Nil.
N_2O_5	0·088 parts per 100,000.
Oxygen absorbed in 15 minutes at 80° C.	0·0304 „ „
After 4 hours	0·0700 „ „

Number of organisms per C.C. = 172.

Except in one instance I did not find the surface wells outside Pretoria yield an impure water. At the same time there can be no doubt but that they were open to a surface pollution. The water passed through them with such rapidity that they were soon cleansed. They were an unsafe source of supply unless very carefully guarded, and, where it was possible to do so, the Pretoria water supply was laid on to the camps outside the town.

On the other hand, troops in camps outside these towns, and those on the march, had to depend on surface supplies from shallow wells, from spruits, or from ponds (vleis).

It was next to impossible to connect cases of enteric fever or dysentery with such sources of supply.

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DRAWING WATER FROM SPRUITS.

Many men, sick and convalescent from enteric fever, whom I interrogated denied drinking any water, except in the form of tea or coffee. One medical officer, who was most seriously ill with enteric fever, was so impressed with the idea that water was the most probable cause, that he saw all the water he used boiled, and he could not understand with all the precautions he had taken how he had contracted the disease. He said no one could have been more careful than he was.

It was also remarkable how seldom, comparatively, were men attacked by these diseases in the blockhouses. The reason of this I believe to be that few men occupied them (10 to 12). They were removed from the danger of contracting these diseases either from personal contact or from clothing, and they were comparatively free from flies, which found little refuse around these structures on which to congregate.

As a rule, blockhouses or any places where a few men were stationed were free from enteric fever or dysentery. It clearly showed that density of population is a very important factor in the dissemination of both these diseases.

Very stringent orders were issued to all units that the water used for drinking purposes should be boiled before distribution, and for this purpose Sawyer's boilers were provided and an extra fuel allowance issued.

My experience was that these instructions were, as a rule, carefully carried out under regimental arrangements; Berkefeld filters were also provided and issued to each company.

From very careful investigation into the sanitary condition of the camps, and tracing as far as possible the numbers admitted to hospital from the various camps, I have come to the conclusion that infected water was not *the* only factor in the spread of enteric fever in the Army in South Africa, and that other causes operated in the diffusion and spread of the disease to a greater or less degree.

As a further proof of this, I believe, when the figures are worked out and in a condition to be analysed, it will be found that officers suffered only in somewhat lessened (if not in very much the same) proportion as the men. This, if true, is important, for officers, as a class, are exceedingly careful about drinking water that had not been previously boiled. As yet we have no accurate figures to test this statement, but from personal observation I believe it is true.

Of course there were exceptions to these views: in a country of the size and extent in which our troops operated, it is necessary to summarise our experiences, on the whole, of the facts under review and not to emphasise individual cases, dogmatise on them and make them applicable to the entire Army scattered over half a continent.

The exceptions are Bloemfontein, Kroonstad and one or two towns where a polluted supply was distributed, and in these places enteric fever was endemic as well as epidemic.

Difficulties also occurred in carrying out the regulations with regard to boiling water for the columns on the march. In many districts traversed there was no wood or other fuel, not even brushwood, and the lack of transport was such as to place the men on short rations. These troops did not suffer: they were comparatively healthy while on the march, but sickness appeared when they went for a few weeks into standing camps.

8. Milk supplies.

The milk supplies were not satisfactory, but I could not trace any connection between the distribution of milk and the occurrence of cases of fever. All milk was "Pasteurised" before issue in the hospitals. The usual adulteration was water and the abstraction of cream. The following analyses shows the general character of the milk supplies:—

ANALYTICAL Figures on Milk Samples, Pretoria, November, 1900.

Number of Sample.	Specific Gravity of Milk.	Specific Gravity of Serum.	Percentage of Solids.	Percentage of Fat.	Percentage of Solids not Fat.
1	1·0357	1·0317	11·69	2·00	9·65
2	1·0290	1·0279	11·04	3·04	8·00
3	1·0241	1·0241	9·93	3·04	6·89
4	1·0291	1·0276	11·57	3·37	8·20
5	1·0286	1·0266	9·94	1·35	8·59
6	1·0247	1·0237	10·64	3·38	7·26
7	1·0266	1·0250	11·13	3·51	7·26
8	1·0251	1·0234	9·80	2·73	7·07
9	1·0279	1·0261	10·91	3·68	8·23
10	1·0266	1·0248	10·73	3·17	7·56
11	1·0249	1·0195	7·94	1·29	6·65
12	1·0313	1·0289	12·70	3·84	8·86
13	1·0239	1·0256	11·09	3·00	8·09
14	1·0211	1·0290	12·36	3·61	8·75
15	1·0201	1·0287	12·72	4·10	8·62
16	1·0194	1·0191	8·64	2·96	5·68
17	1·0311	1·0286	12·99	4·12	8·87
18	1·0227	1·0222	10·03	3·35	6·68
19	1·0333	1·0311	13·47	4·05	9·42
20	1·0295	1·0232	12·11	3·73	8·38
21	1·0309	1·0282	11·50	3·04	7·96
22	1·0278	1·0251	9·89	2·24	7·65
23	1·0279	1·0256	10·91	3·06	7·85
24	1·0260	1·0235	9·78	2·45	7·33
25	1·0224	1·0205	8·60	2·70	5·90
26	1·0222	1·0201	7·66	1·56	6·10
27	1·0330	..	12·27	3·12	9·15
28	..	..	..	..	..

9. Disposal of excreta.

In camps enteric fever and dysentery are always more prone to assume an epidemic character than in civil life in England. The reason is that camp life does not lend itself to the disposal of excreta and refuse, as carried out in towns and villages. Enteric fever and allied diseases bear a direct relationship to the means adopted for the disposal of excrementitious matters. Once a regiment or company becomes infected the latrine is the common foci from which the disease is spread, and this infection may occur before the disease is recognised. Much has been said and written on the dissemination of these diseases, in the Army in South Africa, by water. Without desiring in the least to minimise the great necessity that must always exist for an ample supply of pure water, I am convinced that it is to the system of latrines and general fouling of the soil in camps is to be attributed the evils of camp life, and if we are to effect permanent improvement in the standard of health we must look to these, to prevent the occurrence of disease in an Army in the field. Trench latrines are a constant source of danger, and in South Africa were, I believe, the means of disseminating disease. To these and to personal contact with infected men I attribute a large proportion of the numbers admitted to hospital.

So subtle is enteric fever in its outset, that it may not be recognised until long after the enteric bacilli have infected the latrine and one individual becomes a source of danger to others.

To disinfect, burn or otherwise destroy the bacilli in the excreta from patients in hospitals affords but very partial means of prevention.

To eliminate with any degree of certainty this ever present source of danger, the excreta of both the sick and the healthy should be disinfected.

The system of trench latrines is the one universally adopted in the British Army. With an Army in the field and where the site has to be occupied only for a few days, no other system appears to be practicable, but for standing camps in a country like South Africa it is one of the worst systems to adopt.

It is almost impossible to impress on the soldier the necessity for covering his fæces, and flies swarm on the excrement before it is possible to cover it.

In all standing camps, if they are to be kept in a proper sanitary state, it will be necessary to employ men (natives) under a proper organisation and arrange for the removal of all excreta from them in sanitary carts for cremation or other disposal outside the camp.

From personal observation of many camps in South Africa, I am prepared to say that the regulation system of latrines was carried out as well as the system permits; there is no question of more importance than this in the hygiene of camps, and if our object is to abolish, as far as possible, these diseases, we must be prepared to accept the principle that only a proper conservancy with the complete removal and destruction of filth can effect fewer deaths and less sickness in an Army in the field.

The organisation of such a system on the lines which exist in the Indian Army is not only very desirable but necessary.

In the military hospitals in South Africa there were two methods adopted for the disposal of all excreta. One, by boiling: the liquid and solid excreta, after disinfection in the ward, were boiled in ordinary pot boilers.

This method is unsightly and I think offensive; the ladling out of the boiled fæces is a dirty and disgusting process, and is always open to objection. If this plan was adopted where a system of sewerage exists and where the fæces after boiling could be disposed of, some arrangement for cooling the container must be provided, otherwise the hot liquid entering the drains would crack them or their expansion would displace joints.

A far more cleanly method is to mix the fæces with ashes or other dry material and burn in a small cremator. I recommended this plan for several hospitals in South Africa and experience shows that it answers perfectly. It is in use at Kroonstad, Bloemfontein and other places.

10. Soil pollution.

The condition of the soil in South Africa increased the dangers incidental to soil pollution. The soil itself which is alluvial clay is deficient in the salts of lime and potash, the alkaline bases. There is little limestone in the Transvaal or Orange River Colony (see geological map attached).

The soil too does not lend itself to the disintegration and breaking up of organic matter. Dead animals and organic filth remain for months without undergoing the natual process of decay, and lie as putrifying masses apparently slowly melting away.

In the same way bodies buried in cemeteries emit foul emanations from the ground, so much so, that lime had to be freely used at the time of burial, to prevent a nuisance. Those plants which are indicative of nitrogen ferments in the soil, such as the *vetches* and the *leguminosae* generally are conspicuous by their absence, in fact there appears to be an absence of nitrifying organisms in the soil, and this is further shown by the small amount of nitrogen acids found present in water.

All these conditions indicate that the soil itself uncultivated and not submitted to the action of growing plants, is not in a condition to receive and render harmless, organic filth deposited on circumscribed and small areas, densely populated and with a total absence of any sewage disposal system.

The clay in use in the pits had almost no absorptive power and the results of these conditions were a quantity of fæcal matter, constantly exposed, and covered with flies, which as I have stated acted as the chief agents in disseminating disease, even when lime was used it did not stop these pests from invading the pits.

I cannot too strongly emphasise the importance of formulating an adequate system of conservancy. Until some really efficient system is established, I believe the same results will follow, especially when troops are called on to campaign in countries like the Transvaal and Orange River Colony.

Soil pollution has long been recognised as intimately associated with the spread of enteric fever. Sir Charles Cameron, C.B., states, "in Dublin the zymotic death rate has greatly declined, but still typhoid fever more than holds its own; I can only account for this by assuming that the microbes have established themselves in the soil, that they multiply therein, and that they issue occasionally from it into the atmosphere, which consequently becomes infected. It is only in this way that we can reasonably account for the periodic character of the disease, for its seasonal intensity, for its epidemics.

In the soil, therefore, we must look for the cause of the endemicity of typhoid fever in Dublin and in other places."

This theory is greatly strenghtened by the fact that the porous soils are to a much greater extent likely to be the habitat of the organism than the stiffer clays. The conditions of existence for all kinds of organisims are more favourable in loose soils than in adhesive clays in which air cannot freely circulate.

Sir Charles Cameron also pointed out that on gravel soil the ratio of cases to the population was 1 in 92·8, and on clay soil 1 in 145·3.

Dr. J. Jameson, Medical Officer of Health, Melbourne, maintains that fouling of the soil from want of a sewerage system had much to do with the great prevalence of typhoid fever in Melbourne (*Lancet* March 24, 1900.)

Dr. Wheaton in 1894, in reporting on the prevalence of enteric fever at Mold, states that the fever in all instances occurred in houses where unwholesome conditions existed, chiefly among which was the contamination of the soil around the dwelling by the soakage of filth from open midden steads and from defective drains. The fever was not spread by means of water or milk, but in some instances probably by emanations from defective sewers, in others by means of privies which had become infected by the excreta of sick persons; in others again by contagion within households.

In 1896, Dr. Timbrell Bulstrode reported on an epidemic of enteric fever at Chichester. He states "that the localities mainly invaded were those that have been repeatedly invaded in former years"; the disease was due to the pollution of the soil by defective privies and cesspools, and this had operated as the principal cause of the endemicity of enteric fever.

In the same year Dr. Bruce Low reported on the continued prevalence of the disease at Middlesborough, Yorkshire. This prevalence he attributed to the fact that there were "over 3,000 privy middens in the town in proximity to dwellings, a continued source of pollution of soil and air of the place, and affording favourable conditions for fostering of filthy diseases like enteric fever. Befoulment of the street surface during the process of emptying the middens constitutes continual source of danger. No suspicion attached to the public water supply nor to the milk service."

Again, reporting on the presence of enteric fever at Southend, Dr. Bruce Low says: "its persistence was associated with the pollution of the porous soil, on which the town is built, by human excrement."

Instances such as these could be given indefinitely, showing the views of the best observers and the conclusions drawn from their investigations, they emphasise the opinion I have expressed that the pollution of soil in standing camps is one of the chief factors in the dissemination of camp diseases; the prevention lies in making adequate provision for camp conservancy and the thorough disinfection and removal of all excrementitious matters.

In no city or town in South Africa that I visited have I seen a proper system of sewage disposal.

Those towns bordering on the sea coast discharge their sewage into the sea, while those situated inland, without exception, adopted the pail system, without any admixture of dry earth or other deodorant. Surface waters are made to flow into the nearest spruit or water channel. It is thus that excrement is disposed of in Pretoria, Bloemfontein, Kroonstad, and in fact in every town I could name in the Transvaal, Orange River Colony, Cape Colony, and Natal.

Such a system must be regarded as "nothing short of a relic of ignorance and barbarism which ought not any longer to be imposed on or permitted within civilised communities."

11. Density of population in camps and personal contact.

The density of population in camps is an important factor in furthering the spread of any infective disease. On active service the ordinary bell tent is assumed to afford protection sufficient for 15 men. It is made of duck, provided with 6 inch eaves to carry off water clear of the walls and has three small ventilators covered with bibs. The tent weighs 41½ lbs.; has an internal capacity of 623 cubic feet, and its diameter is 13 feet, the height of the walls is 2 feet 2 inches and the pole is 9 feet 9 inches long. Ventilation is most imperfect as the holes are so small that the movement of air is almost imperceptible. There is little ventilation through the canvas and none at all when it is wet with dew. Some of the new pattern have a few openings for

ventilation made in the canvas near the pole and this is an improvement on the older pattern.

There are 3,097,600 square yards in a square mile and assuming, as was most frequently the case in South Africa, that there are 15 men to each bell tent, the following table gives the surface area per tent for different densities of population per square mile.

Number of Square Yards per Tent.	Number of Tents per Square Mile.	Number of Troops per Square Mile at 15 Men per Tent.
50	61,953	929,280
100	30,976	464,640
200	16,488	232,320
400	7,744	116,160
800	3,872	58,080
1000	3,097	46,464

Assuming the strength as in column 1 and using these measurements, the following table gives the density of population :—

——	Strength.	Square Yards.	Acres.	Men per Acre.	Men per Mile.
Infantry battalion, full size ..	1,011	21,600	4·46	226	144,640
„ „ minimum ..	1,011	7,800	1·61	628	401,920
Cavalry regiment, full size ..	630	34,000	7·02	89	56,960
„ „ minimum ..	630	15,000	3·09	204	130,500
Battery, R.A.	154	11,200	2·31	67	42,880
Field company, R.E.	182	7,500	1·54	118	75,520
Bearer company, R.A.M.C. ..	66	8,400	1·73	38	24,320
Field hospital	145	11,200	2·31	62	39,680

These tables show that a cavalry regiment encamped upon its maximum area is nearly as densely populated as Liverpool which has a population of 97·3 persons to an acre; and when occupying its minimum space would have as dense a population as Whitechapel, which is the most crowded part of London, while on its minimum encamping area it has a density of population more than twice that of Liverpool.

It is not difficult to understand the danger of infection from close proximity of infected to healthy men in tents, in the early stages of disease and before it necessitates their reporting sick. The enteric bacilli are able to exist in cloth and woollen clothing for upwards of two months and in cloth fouled by liquid fæces the micro-organism is recoverable in 16 days. The evidence that enteric fever is communicable from person to person has been slowly but surely accumulating and few now would deny this source of dissemination. Many instances of men, admitted from the same tent, occurred in South Africa, and the tendency, hitherto perhaps, was too often to neglect the personal factor of direct infection and to seek a possible cause outside the tent or camp.

The opinion of those investigators best able to form a correct opinion is certainly in favour of the contagious character of the disease.

Dr. Bulstrode states that "the view is certainly gaining ground that enteric fever is more directly communicable from the patient to the nurses and attendants than was formerly supposed"; and Dr. Niven, of Manchester, traced 53 cases out of 484 to direct infection.

This factor of personal infection was very clearly demonstrated at Green Point, Cape Town. This camp had an excellent supply of water and no fault could be found with the conservancy arrangements. Over and over again outbreaks of enteric fever occurred and these in every instance followed on the arrival of an infected party of invalids sent from up country and who were

detained on arrival at Green Point until they could be disposed of. There could be no doubt that the infection was caused by these convalescents either in their clothing or by personal contact.

Dr. Morehead, a civil practitioner, practising at Middleburg, Transvaal, told me that when at Burghersdorp in 1898 he saw two fatal cases of enteric in Kaffirs, and he had an opportunity of making a *post-mortem* examination which confirmed his diagnosis; these men came from Johannesburg and the severe epidemic which then occurred in Burgersdorp was introduced by tramps into that town on their way to Ladygray, some dying along the road and infecting the district.

Dr. Morehead described a peculiar form of fever which occurs at Middleburg, believed by residents to be malaria, but closely resembling enteric fever.

The disease occurs in the same family about every year, especially in those living on the banks of the Great Oliphant River. It is characterised, by its sudden onset, high temperature (105) and headache, there is no diarrhœa and no spots. Quinine given in large doses has no effect. The fever lasts for two or three weeks, it is, he states, very like enteric but it recurs in the same individuals year after year. Dr. Pittet examined the blood of these persons and states that in nearly every instance he found pigmented bodies.

There is no dysentery in this district. Dr. Morehead was in medical charge of the Boers under General Lucas Meyer outside Ladysmith during the siege of that town and during the whole time there was only one case of enteric fever and no dysentery. Very few cases of dysentery or enteric fever occurred among the Boers on the western side during the war, the reason of this is probably the immunity conferred by a previous attack and the influence of acclimatisation. Dr. Dalgliesh, of Bloemfontein, states "that every fever that occurs is mild typhoid; there is no other class of fever, veldt fevers last from three to six weeks and the temperature is 105° at 5 p.m. with usually a sub-normal temperature in the morning. Veldt fever or camp fever is no doubt enteric fever." He has never seen a fatal case of enteric in children under 12 years of age.

All the chief practitioners whom I interrogated state that dysentery is very seldom seen in the Transvaal or Orange River Colony. The cases I saw in hospitals certainly differ widely from cases of dysentery seen in India and the tropics, the almost total absence of the dysenteric odour from the patient or from the stools is very noticeable; further hepatic congestion and enlargement of the liver is absent and hepatic abscess never, that I know of, follows. I have never seen a case of abscess following dysentery in South Africa.

Dr. Dalgleish informed me that colitis is common in summer; it is very obstinate and very prolonged, the temperature is irregular. The stools contain mucus and often blood, mixed with fluid like the white of an egg. Enemata are not retained and tenesmus is very painful. Dr. Stollreither states that since he commenced practice in 1882 he has seen very few cases of dysentery, and these were for the most part imported. Colitis is rather common with catarrh of the rectum.

During the South African war it was impossible (owing to the composition of the force, the numbers of columns constantly moving, extending and operating over an immense country, the force itself constantly breaking up and re-forming) to obtain statistical information, extending over a sufficient period of time, to admit of conclusions to be drawn from figures.

The statistics of the force will have to be taken from Army records and subsequently analysed. The statements here made are the result of very careful observations and notes, and if not supported by figures they must not therefore be considered as without interest. Figures will, I am certain, bear out what is stated in this report.

12. Present state of our knowledge regarding etiology of enteric fever and dysentery.

In connection with this subject, I cannot resist giving expression to the the views of M. P. Remlinger and M. G. Schneider of the Val-de-Grâce, 1897, quoted by Professor W. H. Corfield.

In the journal of the Pasteur Institute for February, 1897, is a paper by M. B. Remlinger and M. G. Schneider, of the Val-de-Grâce Laboratory, on the Ubiquity of the Typhoid Bacillus. The authors attempt to answer the question, "Does the bacillus of typhoid exist in nature outside the sick man

and the products which emanate from him?" A series of experiments extending over many months was carried out on various materials, such as the public water supplies and wells of several towns having epidemics of typhoid, the soil and dust from different localities, the discharges from the digestive tract of persons not affected with typhoid, &c., and a bacillus giving all the principal laboratory reactions of that of typhoid was obtained from all these sources. The following illustrations are of special interest. In 13 samples of soil and dust the bacillus typhosus was found seven times: (*a*) in the refuse from barracks where there were some cases of typhoid; (*b*) in dust from the laboratory floor; (*c*) in the space between the joists of a room in other barracks; (*d*) in four specimens of soil, both superficial and a metre in depth, from the courts and gardens of Val-de-Grâce. These in three instances were pathogenic for animals. In the examination of the fæces of 10 persons treated at the hospital for affections which had nothing in common with typhoid, five reacted like the bacillus typhosus. Thus (*a*) in a case of leukæmia specimens examined at intervals of 15 days gave each time a positive result; (*b*) in one case of acute tuberculosis without intestinal lesions; (*c*) in a case of premonitory dysentery; (*d*) in two cases of chronic malaria. None of these patients had ever had typhoid fever. Of the bacilli from these five cases, four were pathogenic for guinea-pigs. In many additional cultures from water, soil, and the intestines, bacilli with every characteristic of bacillus typhosus were found, except that they were not pathogenic for animals and were not agglutinated by the serum from a typhoid patient. In other words they seemed the same species but attenuated as to virulence. After some remarks illustrated by comparisons with the variations of the cholera vibrio, these investigators state: "It is allowable to suppose that facts of a similar kind reproduce themselves in connection with the bacillus typhosus. The species of the bacillus of Eberth comprehends, perhaps, varieties more or less numerous which do not probably re-act similarly under the influence of the serum of an animal immunised against a determined variety. The belief in the invariability of type in pathogenic microbes is to-day much weakened by many facts. The question of race, descendants from a common stock but altered by unknown vicissitudes, acquires an importance which must not be under-rated. Why should not this theory apply to the bacillus typhosus? We incline to think that bacilli not pathogenic and indifferent to the serum test which are encountered in water, soil, &c., are only varieties of the bacillus typhosus; at least, the parentage is evident even if the identity is not absolute. This diversity of fundamental type will perhaps serve to explain the variable forms of typhoid infection which are becoming recognised. If this interpretation of facts is exact the following conclusion will result. The bacillus typhosus is distributed in nature outside the human body; it is found in potable waters, in soil, in the intestines of persons not attacked with typhoid, and without doubt forms a part of the microbic flora of the media which surrounds us. This idea is not subversive of recognised facts as to the general etiology of typhoid, but rather enables us to conceive and comprehend facts otherwise inexplicable. Daily observations, especially noted in rural places, have set in relief the part played by contagion in the formation and extension of certain epidemic centres; their value remains. Modern researches have demonstrated the prime importance of impure waters in its development and spread; the character of the proof defies all question. But all the cases must originate from contagion or water polluted with the dejections of typhoid patients. Many times it breaks out in patients or groups worn out with fatigue, overwork, or privations, or after eating various foods, without its being possible to trace the origin of the contagion or the use of a badly polluted water.

"The facts conform more easily with the idea of the widespread presence of the bacillus typhosus, which accounts for its dispersion in surrounding media and its presence eventually in our natural cavities. A water reputed pure may carry it. Thus introduced into the organism it will live there unoffensive till some depressing circumstance, a fortuitous assistance, perhaps, the result of some associated microbe, will open it to a career of action."

A large number of cases of fever examined by Dr. Dodgson gave a decided reaction with Widal's test; he employed the sedimentation method chiefly, recommended by Dr. A. E. Wright.

We know that the results of serum actions are uncertain, even when the agglutination method is adopted. Dr. Lorrain-Smith showed that a very considerable percentage of the patients he examined gave not only Widal's reaction, but also more or less pronounced reactions with the B. Coli Communis.

It has long been held that B. Coli has a share in the causation of enteric fever, and Sanarelli's experiments on the influence of coli toxins in raising the virulence of the B. typhosus has emphasised this fact.

Man may have enteric bacilli in an attenuated form in his intestines, and may remain in perfect health, but if another toxin invade the body it may add new virulence and activity and establish the specific disease. It is, indeed, not only possible, but in many cases the fact that enteric fever followed on dysentery, the above statement proves that dysentery may be said to have determined the attack of enteric fever.

There is, therefore, a causal relationship between both these diseases, which throws considerable light on the subject. It will account for those cases which are said to arise *de novo*, and which the medical history of the Boer War goes in every way to disprove.

The universality of enteric fever in armies in the field is admitted by every nation. In the Franco-German Army, operating in Europe under conditions vastly different to the British forces in South Africa, the number of cases of enteric fever amounted to 73,396, or 9·31 per cent. of the average strength of the whole Army. In the Autumn of 1870 there was not a regiment in the German Army free from enteric fever. The Army traversed a country well supplied with water, yet wherever it went it carried enteric fever with it, and by personal infection infected regiment after regiment.

In summarising my views as to the probable causes of the prevalence of enteric fever and dysentery in the Army in South Africa, I submit the following opinions :—

Summary of views as to causes, &c.

1. That in the absence of a fuller knowledge of the nature of dysentery, it is sufficient to regard both this disease and enteric fever as being essentially filth diseases, and both due to bacillary organisms intimately associated with and given off by the excretory products of men and animals. Further, that as far as their general etiology is concerned, both diseases may be considered to have a common origin.

2. That the prevalence of enteric fever and dysentery among the troops in South Africa cannot be explained as being due in all cases to any one specific insanitary condition, but that various conditions contributed to the incidence and dissemination of these diseases in different places.

3. That in some places these diseases were carried by the use of foul water (notably water from public supplies) which had been polluted, not only by the excreta of men and animals, but also by the decomposing bodies of animals.

4. That in many places where enteric fever and dysentery were specially prevalent, the condition of the water supplies were insufficient to explain the occurrence of these diseases, but that in those cases it could be accounted for by the influence of close aggregation of men and animals in small encampments, fouling of the soil, the occurrence of personal infection, the effects of the swarms of flies which covered food, the men themselves, their clothing; and haunted the latrines and other places for disposal of refuse.

5. That the influence of impure water, aggregation in crowded camps, fouling of soil, the prevalence of flies as carriers of specific filth, was accentuated by the preponderance of young men in the ranks and by the exhausting nature of the military work which these young soldiers had to perform.

6. That notwithstanding the greatest care and precautions for the safeguarding of the generally accepted sources of these diseases, it is practically impossible to completely prevent their occurrence in an Army hastily mobilised, operating in a country in which water is scarce, and whose ranks are largely filled with young men at an age notoriously liable to be affected by diseases of this nature.

7. That in spite of the many difficulties favouring the incidence of enteric fever and dysentery in an Army of young soldiers in the field, much can be

done to lessen both the incidence and mortality from these affections by suitable and adequate sanitary measures.

8. The essential sanitary measures are the following :—

(*a*) The safeguarding of water supplies by a proper system of police.

The elaboration of a proper system of preparing and issuing a clean water to individuals : this can only be done by organising a system, within the various units themselves, of purifying water by either boiling or filtering.

(*b*) A proper system of disposing of excreta and refuse.

In standing camps abolish trench latrines, but provide pail closets and sanitary carts for removing the same to a point outside the camp, where it should be either cremated in a destructor or deeply buried. In camps occupied for less than six days, trench latrines are a necessity but need vigilant supervision. All camp refuse should be burnt.

(*c*) The organisation of a *cadre* of men for scavenging work. This point is practically the pivot on which the whole question of camp sanitation turns. We have no such organisation in peace, when all this class of work, so far as the Army is concerned, is performed for it by civil contractors. The result is, that the moment the British soldier leaves his lines and the contractor, he is unable to deal with and dispose of his own refuse material.

Regarded as a purely fighting agent, the soldier himself is not fitted for this class of work : the only solution is the recognition of the need for and the maintenance of a special *cadre* for this purpose.

This principle has long been recognised in India.

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